ARITHMETIQUE

Made easie,

OR,

A perfect Methode for the true knowledge and practice of *Natural Arithmetique*, according to the ancient vulgar way, without dependence upon any other *Author* for the grounds thereof.

By Edm. WINGATE Esquire.

The second Edition.

Enlarged (at the request and with the approbation of the Author*) with divers* Chapters *and necessary* Rules;

Together with an *Appendix* containing 7 *Chapters*, whose *Contents* are as followeth, *viz.*

Chap.

1 *Of* Rules *of* Practice.
2 *Of Exchange of* Coins, Waights, *and* Measures.
3 *Of* Interest *of* Money.
4 *A Geometricall Demonstration of the* Rule of Alligation alternate; *where, of the* composition *of* Medicines.
5 *A Geometricall Demonstration of the* Rule *of* False.
6 *Subtile and pleasant Questions, exercising all the parts of* Naturall Arithmetique.
7 *Recreative Questions, exercising* Symbolicall Arithmetique, *and the* Rule *of* Algebra.

By JOHN KERSEY *Teacher of Mathematiques.*

Boëtius Arith. lib. 1. cap. 2.
Omnia quæcunq; á primævâ rerum naturâ constructa sunt, Numerorum videntur ratione formata: Hoc enim fuit principale in animo Conditoris Exemplar.

LONDON,
Printed by *J. Flesher* for *Phil. Stephens* at the Gilded *Lion* in *Pauls Church-yard.* 1650.

To the right Honourable, THOMAS, Earle of *Arundel* and *Surrey*, Earle Marshall of *England,&c.*

Right Honourable,

T*He good affection you beare to all kinde of* Learning, *and in particular to the* Mathematiques, *makes me adventure to present your Lordship with this Tractate of* Arithmetique, *because that Art, compared with other Mathematicall Sciences, is as the* Primum Mobile, *in respect of the other inferiour Orbes:*

 For

For as the Poets used in times past to say of Venus, Sine Cerere & Baccho friget Venus, *so may I also confidently averre of them, without* Arithmetique *they are poore, and without Motion Presuming therefore that your Lordship, loving the Art, cannot disaffect the Artist, nor his intention to doe good in that kind, I am bold to shelter this Treatise under your Lordships protection, humbly intreating gratious acceptation, and earnestly desiring for ever to remain,*

Your Honours, in all service affectionately devoted

Edm. VVingate.

The Preface to the second Edition of this first Book:

Relating also to the other Books already published by the *Anthour*.

About twenty yeares since, after I had in some measure before that time exercised my self in the study of the *Mathematiques*, and by that means discovered some expeditious wayes of working by *Logarithmes* (an invention then both fresh and rare) which (as was then conceived) might be usefull for the publick, at the instance of some of my friends, I framed two Books of *Arithmetique*, intending the first (being this) onely as a key to open the secrets of the other, which treats of *Artificiall Arithmetique* performed by *Logarithmes*; and therefore did then in that first (for brevity sake) omit divers pieces of naturall or vulgar *Arithmetique*, which for the perfect and universall understanding thereof were necessary to have been inserted; Howbeit, now the first impression of both those Books being spent: I have been of late importuned to take some care of this second Edition, and being given to understand that (by reason of the Method) it had been generally well approved, and much used by divers, that teach *Arithmetique*, I promised my endeavour therein;

What was the Authors designe in the first Edition of this Book.

What was omitted then.

but not long after foreseeing that my other necessary imployments would much retard the perfecting thereof (as I did intend it) I imparted my thoughts concerning the same to M^r. *John Kersey*, whom I did know to be an Industrious Man, well experienced in teaching that Art, and was Instant with him to take the pains of inserting such Chapters, Rules and Examples into this first Book, as I then mentioned unto him, and also to adde what else he should conceive necessary to make it *opus absolutum*, a perfect work; All which he hath performed by divers insertions in severall places of the work, besides the addition of certain Chapters (intirely his own) relating to severall particulars, as doth more fully appear in the Table prefixed: So that for understanding naturall or vulgar *Arithmetique*, there is (as I conceive) no need of repairing to any other Author for supply thereof. My desire likewise was, that it might be fitted for the best advantage of such as teach that Art, as well in respect of method and order, as also of compendiousnesse, truth, and exact correction, both of the Text and Numbers: This also hee hath faithfully endeavoured to perform with as few mistakes or errours as may probably bee expected in a worke of this nature: So that (it is confidently hoped) the Reader having diligently perused this first Book, may thereby obtain compleat knowledge in Naturall or Vulgar *Arithmetique*, which I have thought convenient to bee Printed apart from the other, to the end that such as will content themselves with this of *Naturall Arithmetique* may not be charged with the buying of the other, unlesse they so please; nevertheless, if they (having herein passed the more rugged

The course taken for supply now.

To make this a perfect work.

What is now added.

For the benefit of the teachers of this Art.

And the Readers obtaining compleat knowledge in vulgar Arithmetique.

Why this first part printed alone.

rugged and uneven pathes of *Naturall Arithmetique*) are afterwards desirous to understand the grounds and order of *Arithmetique Artificiall*, they shall be by the other Book conducted thereinto as into a plain and spacious Champaigne, where the wayes are smooth and easie to passe; for what they shall finde here performed by *Multiplication* and *Division*, they shall be there taught to expedite by *Addition*, and *Subtraction*; and the extraction of rootes a more easie way yet, *viz.*

That of the *Square roote*, by *Bipartition* or *Division* by 2; and the other of the *Cube Roote* by *Tripartition* or *Division* by 3. Howbeit the last Booke cannot be well understood without a perfect knowledge of the first, divers Rules of this opening the way to the discovery of that: Nevertheless, (if before the second Booke can bee conveniently published) any shall desire some generall light of working by *Logarithmes*, hee may (in the mean time) bee in some competent measure acquainted therewith by my other Bookes heretofore published, Intituled, 1, *The Construction and use of the Logarithmicall Tables.* 2 *The use of Logarithmes in Geometrie, Astronomie, Geographie*, and *Navigation*: And 3, *The use of the Rule of Proportion*; before the second of which is also prefixed a Table of an Hundred thousand *Logarithmes* ingeniously contracted by Master *Roe*, and exactly corrected at the Presse by Master *Butler* deceased: Howbeit in these last mentioned Treatises, he must not expect to finde the Universall use of *Logarithmes* throughout all the parts of *Arithmetique*, which the second Booke (now intended) will afford him: For what this Booke presents

What is included in the second part.

How the Authors intention for the 2 Book is in part already performd by his other Books published formerly.

presents unto you, according to the antient vulgar way of working by the *Numbers themselves*, the other that followes performs the same by *borrowed Numbers* called *Logarithmes*; And both these taken together contain in them an intire body of *Arithmetique* both *Naturall* and *Artificiall*, which if accepted with as cleare an affection as intended, 'tis all I looke for, expecting nothing for the fruit of my labours, but favourable acception, and (in that) the publique good.

Edmond Wingate.

The

The *Books*, mentioned in the Preface, are sold by *Philemon Stephens* at the gilded-Lion, in *Pauls Church-yard.* viz.

1. THe Construction and use of the *Logarithmeticall* Tables, whereby *Multiplication* is performed by *Addition*, *Division* by *Subtraction*, and the resolution of *Triangles* right lined and *Sphericall* by *Addition* and *Subtraction*. First published in *French*, now the third time printed in *English* in 12°.

2. Two Tables of *Logarithmes*: the first containing the *Logarithmes* of all numbers from 1. to 100000. contracted into a portable volume, by *N. Roe*. The 2d. the *Logarithmes* of the right *Sines* and *Tangents* of all the Degrees and Minutes of the quadrant, each Degree divided into 100. minutes, and the *Logarithme*, of the *Radius* or *Semidiameter* being 10, 00000 00000.

To which is annexed their admirable use for resolving Problemes,

in

in { *Geometry*, *Astronomy*, *Geography*, & *Navigation*.

3. The use of the Rule of *Proportion* in *Arithmetique* and *Geometrie*, wherein is inserted the Construction and use of the same Rule in questions that concern { *Astronomy*, *Dialling*, *Geography*, *Navigation*, } { *Gaging of vessels*, *Military orders*, *Interest* and *Annuitie*.

4. The Construction and use of the line of Proportion, whereby the hardest questions of *Arithmetique* and *Geometry* in broken and whole numbers are resolved by *Addition* and *Subtraction*, printed in the yeare, 1628.

Also at the same place is to be sold,

Arithmetica Logarithmica, sive Logarithmorum Chiliades centum, pro Numeris naturali serie crescentibus ab unitate ad 100000.
Autore *Hen. Briggio*.

Trigonometria Britannica, sive De Doctrina Triangulorum libri duo.
Autore *Hen. Briggio*.

A Treatise of Globes *Cœlestiall* and *Terrestriall*, written in Latine by Master *Robert Hues*. Illustrated with Notes, by *Io. Isa. Pontanus*, Englished by *Iohn Chilmead* of Christ-Church in *Oxford* 8°.

Rabdologia, or the art of Numbring by Rods, whereby the Operations of *Multiplication* and *Division*, Extraction of Roots, &c. are performed by *Addition* and *Subtraction*, with many Examples for practice of the same, by *Seth Partridge*.

Other Books tending to the *Mathematicall Sciences* are there likewise to be sold.

A Ta-

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These few *Errata*, are necessary to be amended.

Pag.	Line	Faults	Corrected
20	13	24 s. $\frac{647}{960}$	24 $\frac{647}{960}$ lb.
22	4,15	*tenths*	tens
41	22	*lesse*	greater
54	19	*either*	each
67	23	*denominat, or*	denominator,
293	10	525	425
368	6	101 $\frac{4}{2}$	101 $\frac{4}{21}$

THE

ARITHMETIQVE NATURALL.

The first Book.

Chap. I. *Of Number.*

I. ARithmetique *is the Art of accompting by Number.* As magnitude or greatnesse is the subject of *Geometrie*, so multitude or number is that of *Arithmetique*.

II. *Number is that, by which every thing is numbred.* Number. *Vide Rami Arith. cap. 1. prop. 4.*

III. *The Notes or Characters, by which Number is ordinarily expressed, are these;* 1 *one*, 2 *two*, 3 *three*, 4 *foure*, 5 *five*, 6 *sixe*, 7 *seven* 8 *eight*, 9 *nine*, 0 *nothing.*

IV. *These Notes are either significant figures, or a cypher.*

 V. *The*

V. *The significant figures are the first nine*, viz. 1, 2, 3, 4, 5, 6, 7, 8, 9. The first whereof is more particularly termed an *Unit*, or *Unitie*, and the rest are said to be composed of *Unities*: So 2 is composed of two unities, 3 of three unities, &c.

VI. *The Cypher is the last, which though of it self it signifieth nothing, yet being annexed before, or after any of the rest, increaseth, or lesseneth their value*: As shall farther appear hereafter.

VII. *The value of these Notes is expressed by Degrees and Periods.*

VIII. *The degrees are three.*

The degrees of Number.

IX. *The first is the first place of a number towards the right hand, which alwaies signifieth it self once*, as 2 two, 3 three, &c. And this is called the place of *UnITS*.

X. *The second degree is the second place towards the same hand, and then the first note towards the right hand signifieth it self once, as before, and the other signifieth it self ten times*: So these figures 20, signifie twenty, and these 30, thirty, likewise these 23, twenty three, &c. And this second place is called the place of *Tens*.

XI. *The third is the third place of a number, towards that hand and then the first note towards the same hand signifieth it self once, the next ten times it self, and the last an hundred times it self*: So these figures 100, signifie one hundred, these 200, two hundred, these 300, three hundred, and these 123, one hundred twenty three, &c. And this is termed the place of *Hundreds*.

A Period.

XII. *A Period is when a number consisting of moe notes then three, hath each three notes thereof (beginning at the right hand) distinguished by points or commaes; For those severall parts of the number so distinguished, are called Members, or Periods.*

So the number 23437205740304, being distinguished by *Periods* will stand thus, 23, 437, 205, 740, 304. of which in the first *Period* towards the right hand the first figure towards the same hand is, as before, the place of *Vnits*, the second the place of *Tens*, the third the place of *Hundreds*: again in the second *Period* the first figure towards the same hand is the place of *Thousands*, the next *tens of thousands*, and the last *hundreds of thousands*: Then in the third *Period* the first is the place of *Millions*, the next *tens of millions*, and the last *hundreds of millions*: Fourthly, in the fourth *Period* the first are *thousands of millions*, the next

ten thousands of millions, and the last *hundred thousands of Millions* : Lastly, in the fift *Period*, the first are *Millions of Millions*, the next *tens of Millions of Millions*, &c. So that if you would pronounce the number above mentioned, you shall read it *thus*, beginning with the first figure toward the left hand ; 1 Twentie three Millions of Millions. 2 Foure hundred thirtie seven thousand. 3 Two hundred and five millions. 4 Seven hundred and fourtie thousand. 5 Three hundred and foure.

XIII. *Every number is either simple or mixt.*

XIV. *A simple number is that whose parts are of one and the same kind, that is, either whole or broken.*

A whole Number.

XV. *A whole number is that, which consists of Integers, that is, intire Vnities.* As 24 which is composed of foure, and twenty *Integers*, or intire unities.

A Fraction.

XVI. *A broken number (otherwise called a Fraction) is onely part of an Integer*; As if you would expresse in figures the length of a peece of cloth, that contains *three fourths*, or (which is all one) three quarters of a *yard* you are to write it *thus*; $\frac{3}{4}$ that is, an intire yard being supposed to be divided into foure equall parts, the length of

of the peece propounded is *three* of those foure parts : in like manner (a foot being divided into 12 *Inches*) you must write sixe inches *thus* $\frac{6}{12}$: that is, sixe *twelves* of a foot: or if the foot be divided into an hundred parts, to expresse five and twentie of those parts set them down *thus* : $\frac{25}{100}$ that is, five and twentie *hundreds* of a foot.

XVII. *A broken number consists of two parts, the Numerator, and the Denominator.*

XVIII. *The Numerator is the number placed above the Line* : as in the last examples, 3, 6, 25.

XIX. *The Denominator is the number placed under the line:* as these, 4, 12, 100.

XX. *A broken number is either proper or improper.*

XXI. *A proper broken number is that, whose Numerator is lesse then the Denominator:* Such as are the fractions before mentioned $\frac{3}{4}$ $\frac{6}{12}$ and $\frac{25}{100}$.

XXII. *A proper broken number is either single or compound.*

XXIII. *A single broken number is that which* consists of *one* Numerator, and *one* Denominator : Such as are $\frac{3}{4}$ $\frac{6}{12}$ $\frac{25}{100}$ and the like.

XXIV. *When a single broken number* *hath* A Decimall.

hath for his Denominator a number consisting of an unitie in the first place toward the left hand, and nothing but Cyphers towards the right, it is more particularly called a Decimall : Of this kinde are these that follow, $\frac{5}{10}$ that is, five *tenths*, $\frac{5}{100}$ five *hundreds*, $\frac{25}{100}$ five and twenty *hundreds*, $\frac{50}{1000}$ fifty *thousands*, $\frac{25}{10000}$ five and twenty *ten thousands*, &c.

XXV. *A decimall may be exprest without the denominator by prefixing a point before the numerator* : So $\frac{5}{10}$ may be written *thus*, .5. and $\frac{25}{100}$ *thus*, .25.

XXVI. *In decimalls, when the numerator consists not of so many places as the denominator hath cyphers, fil up the void places of the numerator with cyphers* : So $\frac{5}{100}$ $\frac{50}{1000}$ and $\frac{25}{10000}$ are written thus, .05, .050, .0025.

XXVII. *In decimalls thus exprest, the denominator is discoverable by the places of the numerator* : for if the numerator consists of two places, the denominator is an unity with two cyphers : if of three, the denominator hath three cyphers annexed, &c. So the denominator of .25, is 100, and the denominator of .050, is 1000.

A compound Fraction. XXVIII. *A compound broken number, (otherwise called a Fraction of a Fraction) is*

is that which hath more numerators and denominators then one, which kind of broken numbers are discoverable by this word [of] which is interposed between their parts : As $\frac{2}{3}$ of $\frac{3}{4}$ is a Fraction of a Fraction or compound broken number, and expresseth two thirds of three fourths of an *Integer*, viz. a pound *sterling* being supposed the *Integer*, and first divided into foure parts, three of those foure parts are equall to 15, s. Again if the said $\frac{3}{4}$ or 15, s. be divided into three parts, two of those three parts are equall to 10, s. So the said compound broken number $\frac{2}{3}$ of $\frac{3}{4}$ of a pound *sterling* doth expresse 10 s. In like manner the compound broken number $\frac{1}{4}$ of $\frac{3}{4}$ of $\frac{4}{5}$ of a pound *sterling*, that is one fourth of three fourths of foure fifths of a pound *sterling*, doth expresse 3. s. as will be manifest by the 15th. and 8th. *Rules* of the 7th. Chapter.

XXIX. *The things expressed by broken numbers are principally the parts or fractions of money, waight, measure, time, and things accompted by the dozen.* Of the three first of these, there are infinite kindes and varieties according to the diversity of the severall *Common-wealths*, in which they are used, all which here to produce were both endlesse and needlesse : wherefore we intend

intend here to treat onely of such *money*, *waights* and *measures*, as are used in this Kingdome, being indeed onely necessary to be known for our present purpose.

The Fractions. XXX. *The least part or fraction of money used in England is a farthing, from whence is produced this table following.*

1. Of English money.

1. *Farthing.*	*makes*	1. *Farthing.*
4. *Farthings.*		1. *Penny.*
12. *Pence.*		1. *Shilling.*
20. *Shillings.*		1. *Pound sterling.*

In this Table you may observe a pound *sterling*, being esteemed an *Integer*, is divided into 20 parts or *shillings*, so that one *shilling* is a broken number of a pound *sterling* and thus written $\frac{1}{20}$ l. that is, one twentieth of a pound *sterling*; also 7 *shillings* are $\frac{7}{20}$ l. Likewise a *shilling* being divided into 12 parts or *pence*, one *penny* is $\frac{1}{12}$ s that is, one twelfth of a *shilling*; or $\frac{1}{12}$ of $\frac{1}{20}$ l that is, one twelfth of one twentieth of a pound *sterling*: Lastly, a *penny* being divided into 4 parts or *farthings*, one *farthing* is $\frac{1}{4}$ d. that is, one fourth of a *penny*, or $\frac{1}{4}$ of $\frac{1}{12}$ s. that is, one fourth of one twelfth of a *shilling*, or $\frac{1}{4}$ of $\frac{1}{12}$ of $\frac{1}{20}$ l. that is, one fourth of one twelfth of one twentieth of a pound

pound *sterling*. Now albeit the true and naturall way of expressing broken numbers, is by their numerators and denominators, as before, yet the broken numbers or *known parts* of money, waight, measure, &c. are ordinarily (for more convenient operation) expressed like *Integers*, as may appear by the 12th *rule* of the 2 Chapter, and the 5th *rule* of the third Chapter: So if you were to expresse in figures thirteen shillings five pence half penny farthing, the ordinary way to set them down is briefly *thus*, 13-05-ob. qu. or *thus*, 13.s. 05.d. 3.f. or *thus*, 0l 13s 05d. 3f. that is, no pounds, thirteen shillings five pence, three farthings, but the said thirteen shillings five pence three farthings, being distinctly considered as Fractions of a pound *sterling* will be properly written *thus*, viz.

13 *shillings* are thirteen twentieths of a pound *sterling*, and written *thus*, —— $\frac{13}{20}$ l.

5 *Pence* are $\frac{5}{12}$ of $\frac{1}{20}$ of a pound *sterling*, that is (as will appear by the 15th and 3d rules of the 7th Chapter) one fourtie eighth of a pound *sterling*, and written *thus*, —— $\frac{1}{48}$ l.

3 *Farthings*

3 *Farthings* are $\frac{3}{4}$ of $\frac{1}{12}$ of $\frac{1}{20}$ of a pound *sterling*, that is (as will appeare by the 15th and 3 rules of the 7th Chapter) one three hundred and twentieth of a pound *sterling*, and written thus, —— $\frac{1}{320}$l.

Vide Stat. de Compositione ponderum. 51 *Hen.* 3.

XXXI. *The least Fraction of waight used in England is a grain, that is, the waight of a grain of wheat well dried and gathered out of the middle of the eare, whereof 32 make a penny waight, and 20 penny waight make an Ounce Troy.*

31 *E.* 1. *v.* Rast. weights. 7. & 8. 12 *H.* 7. 5.

But here observe, that albeit by the Statutes quoted in the margent, the waight of 32 such grains of wheat make but a *penny waight*, yet the waight thereof being once discovered by 32 such grains, the said penny waight (being the twentieth part of an Ounce *Troy*) is usually subdivided into 24 parts onely, called also *Grains*, as appears by the insuing *Table*.

1. *Graine*

1 *Graine*	waight makes	1 *Graine.*
24 *Graines*		1 *Penny waight.*
20 *Penny w.*		1 *Ounce Troy.*
12 *Ounces. Troy.*		1 *Pound Troy.*
14 *Ounc.* 12 *pen. Troy.*		1 *Pound Averdupois.*
14 *Pounds Averd.*		1 *Halfe quarter of an Hundred.*
28 *Pounds*		1 *Quarter of an Hundred.*
56 *Pounds*		1 *Halfe of an hundred.*
112 *Pounds*		1 *C. That is, An Hundred.*
5 *Hundred*		1 *Hogshead waight.*
10 *Hundred*		1 *Halfe of a Tun.*
20 *Hundred*		1 *Tunne.*

XXXII. *You may observe by the Table aforegoing, that there are two kindes of waight used in England,* viz. *Troy and Averdupois waight.*

XXXIII. *The pound Troy consisteth of twelve ounces Troy, each ounce being again divided into twenty penny waights, and each penny-waight into foure and twentie grains*: wherefore here a pound *Troy* being counted the *Integer*, the ounces, penny waights 2. Of Troy waight.

waights, and grains are taken as *fractions* thereof; so one ounce *Troy* is written *thus*, $\frac{1}{12}$lb. that is, one twelfth of a pound *Troy*: Also one penny waight is $\frac{1}{20}$ ounce, that is one twentieth of an ounce *Troy*, or $\frac{1}{20}$ of $\frac{1}{12}$lb. that is, one twentierh of one twelfth of a pound *Troy*. Lastly, one grain is $\frac{1}{24}$p. that is, one foure and twentieth of a penny waight *Troy*, or $\frac{1}{24}$ of $\frac{1}{20}$ ounce, that is, one foure and twentieth of one twentieth of an ounce *Troy*. or $\frac{1}{24}$ of $\frac{1}{20}$ of $\frac{1}{12}$ lb. that is, one foure and twentieth of one twentieth of one twelfth of a pound *Troy*. So 9 ounces, 8 penny waight and 16 grains being propounded to be written properly as fractions of a pound *Troy* are expressed *thus*:

9 *Ounces* are $\frac{9}{12}$ of a pound *Troy*, that is (as will appeare by the 3d. *rule* of the 7th chapter.) —— } —— $\frac{3}{4}$lb.

8 *Penny waight* are $\frac{8}{20}$ of $\frac{1}{12}$ of a pound *Troy*, that is (as will appear by the 15th and 3d *rules* of the 7th Chapter.) —— } —— $\frac{1}{30}$lb.

16 *Grains* are $\frac{16}{24}$ of $\frac{1}{20}$ of $\frac{1}{12}$ of a pound *Troy*, that is (as will appear by the 15th and 3d *rules* of the 7 Chapter.) —— } —— $\frac{1}{360}$lb.

Or

Or briefly *thus*, (after the manner of *Integers* or whole numbers) 9. Ounces. 8. p. 16. gr. or thus, 0. 9. 8, 16. that is, no pounds, 9 ounces, 8 penny waight and 16 grains.

Now this *Troy waight* serveth onely to weigh bread, gold, silver and Electuaries. And here observe also by the way, that *Troy waight* regulateth and prescribeth a form how to keep the money of *England* at a certain *Standard*, for about two hundred yeares before the Conquest, *Osbright* a Saxon being then King of *England* caused an ounce *Troy* of silver to be divided into twentie peeces at the same time called *pence*; and so an *ounce* of silver at that time was worth no more then *twenty pence* or one shilling eight pence, which continued at the same value untill *Henry* the sixth his time, who (in regard of the inhauncing of moneys in forain parts) valued the same at *thirty pence*, so that then there were accordingly thirty peeces made out of the *ounce*, and the old peeces went then for *three halfe pence*, untill the time of *Edward* the fourth, who valued the *Ounce* at *fourty pence*, and then the old peeces went for two pence a peece. After this *Henry* the eighth, valued the *Ounce* of sterling silver at *fourty five pence*, which value continued untill

Malynes Lex mercat. pag. 49.

Malynes ibid. pag. 252.

Queen

Queen *Elizabeths* time, who valued the same old pence at *three pence* the peece: so that all *three pences*, coyned by the said Queene, weighed but a penny waight, and sixe pence two penny waight; and so in like manner the shilling and other peeces accordingly; which made the ounce *Troy* of silver to be valued at *sixtie pence* or five shillings, as it now remains at this day without alteration.

XXXIV. *A pound Averdupois is composed of* 14 *Ounces*, 12 *pen. troy*. And this *waight* serveth to weigh all kinde of Grossery ware, as also Butter, Cheese, Flesh,
Malynes Ibid. pag. 49. Tallow, Wax, and every other thing, which beareth the name of *Garbell*, and whereof issueth a refuse or waste.

3. Of Averdupois great waight. XXXV. *Averdupois waight is either greater or lesse.*

XXXVI. *The greater is, when an Hundred, consisting of* 112 *pound Averdupois, is the Integer, being subdivided first into foure quarters, and each quarter into eight and twentie pounds: again each pound into foure quarters, or if you will bee more exact, into sixteen ounces, and if you please, each ounce into foure quarters*; and here the quarters, pounds, ounces and quarters of ounces are the parts or fractions of an hundred;

so half an hundred, seventeen pounds, seven ounces, and a quarter, being propounded to be written properly as *fractions* of an hundred, will be thus expressed:

Halfe an *hundred* is, — $\frac{1}{2}$ C

17 *Pounds* are $\frac{17}{28}$ of $\frac{1}{4}$ of an hundred, that is, (as will appear by the 15 *rule* of the 7 Chapter.) — $\frac{17}{112}$ C

7 *Ounces* are $\frac{7}{16}$ of $\frac{1}{28}$ of $\frac{1}{4}$ of an hundred, that is, (as will appear by the 15 and 3 *rules* of the 7 Chapter.) — $\frac{1}{256}$ C

One *quarter* of an Ounce is $\frac{1}{4}$ of $\frac{1}{16}$ of $\frac{1}{28}$ of $\frac{1}{4}$ of an hundred, that is, (as by the 15 *rule* of the 7 Chapter will be manifest.) — $\frac{1}{7168}$ C

Or briefly thus (after the manner of *Integers*) 0. 2. 17. 7. 1. that is, no hundreds, two quarters of an hundred, seventeen pounds, seven ounces and one quarter of an ounce.

XXXVII. *The lesse is, when a pound is the Integer, each pound being subdivided into sixteen ounces, and each ounce again into sixteen drammes, and if you please, each dramme into foure quarters*: and in this 4 Of Averdupois little waight.

this the ounces, drams and quarters are the parts or *fractions* of a pound *Averdupois*: so 14 ounces 5 drammes and a quarter being propounded, to be written as *fractions* of a pound *Averdupois*, will bee thus expressed.

14 *Ounces* are $\frac{14}{16}$ of a pound *Averdupois*, that is (as wil be manifest by the 3 *rule* of the 7 chap.) —— $\frac{7}{8}$ lb.

5 *Drams* are $\frac{5}{16}$ of $\frac{1}{16}$ of a pound *Averdupois*, that is, (as will appear by the 15 *rule* of the 7 Chapter.) —— $\frac{5}{256}$ lb.

One *quarter* of a dram is $\frac{1}{4}$ of $\frac{1}{16}$ of $\frac{1}{16}$ of a pound *Averdupois*, that is, (as will apear by the 15 *rule* of the 7 Chapter.) —— $\frac{1}{1024}$ lb.

Or briefly thus, after the manner of *Integers*, 0.14.5.1. that is, no pounds, 14 ounces, five drams and a quarter.

XXXVIII. *The measures used in* England *are either of capacitie or length.*

XXXIX. *The measures of capacity are those which are produced from waight, and they are either liquid or drie.*

5 Of liquid measures.

XL. *The liquid measures are those, in which all kind of liquid substances are measured, and they are expressed in the* Table *following.*

1 *Pound*

Vide 12. H.7. cap.5.

1 *Pound of wheat Troy w.*	*makes*	1 *Pinte*
2 *Pints*		1 *Quart.*
2 *Quarts*		1 *Pottle.*
2 *Pottles*		1 *Gallon.* (*Herring.*
8 *Gallons.*		1 *Firkin of Ale, sope,*
9 *Gallons*		1 *Firkin of Beere.*
10 $\frac{1}{2}$ *Gallons*		1 *Firkin of salmō, or*
2 *Firkins*		1 *Kilderkin.* (*Eeles*
2 *Kilderkins*		1 *Barrell.*
42 *Gallons*		1 *Tierce of Wine.*
63 *Gallons*		1 *Hogshead.*
2 *Hogsheads*		1 *Pipe or Butt.*
2 *Pipes, or Butts*		1 *Tun of Wine.*

6. Of drie measures.

XLI. *Dry measures are those, in which all kinde of dry substances are meted,* as graine, seacole, salt, and the like; their Table is this that followes.

1 *Pinte*	*makes*	1 *Pinte.*
2 *Pints*		1 *Quart.*
2 *Quarts*		1 *Pottle.*
2 *Pottles*		1 *Gallon.*
2 *Gallons*		1 *Pecke.*
4 *Pecks*		1 *Bushel land measure:*
5 *Pecks*		1 *Bushel water measure*
8 *Bushels*		1 *Quarter.*
4 *Quarters*		1 *Chalder.*
5 *Quarters*		1 *Wey.*

C XLII. *Long*

7. Of long measures. Vide 33. Edw. 1. & 25 Eliz.

XLII. *Long measures are expressed in the Table following;*

3 *Barley cornes*	makes	1 *Inch.*
12 *Inches*		1 *Foot.*
3 *Foot*		1 *Yard.*
3 *Foot* 9 *Inches*		1 *Ell.*
6 *Foot*		1 *Fadome.*
$5\frac{1}{2}$ *yards*		1 *pole or pearch*
40 *Poles*		1 *Furlong.*
8 *Furlongs*		1 *English mile.*

8. Of Time.

XLIII. *A Table of Time is this, that followes:*

1 *minute*	makes	1 *minute.*
60 *minutes*		1 *houre.*
24 *houres*		1 *day naturall.*
7 *dayes*		1 *weeke.*
4 *weekes*		1 *moneth of* 28 *dayes.*
13 *moneths* 1 *day and* 6 *houres*		1 *yeare.*

Howbeit in ordinary computations of *Time*, the whole yeare consisting of 365. dayes, is divided into twelve moneths, each moneth (accounting one moneth with another) containing 30 $\frac{5}{12}$ daies, that is 30. daies and five twelves of a day: And here observe,

serve, that the fractions of *measures and time* are likewise written and pronounced, as those of *money and weight*, their respective termes being observed.

9. Of things accounted by the dozen.

XLIV. *Of things accounted by the dozen, A grosse is the Integer consisting of 12 dozen, each dozen containing again twelve particulars;* And therefore here the dozens and particulars are parts, or *fractions* of a Grosse: So if seven dozen and five points were propounded, to be written properly as fractions of a Grosse, they are to bee thus expressed:

7. *Dozen* are ——— $\frac{7}{12}$ G.

5 *Points* are $\frac{5}{12}$ of $\frac{1}{12}$ of a Grosse, that is (as will be manifest by the 15[th] *Rule* of the 7[th] chap. -------- $\frac{5}{144}$ G.

Or briefly *thus*, (after the manner of *Integers*) 7 doz. 5 points, or *thus* 0. 7. 5. that is, no Grosse, 7 dozen and 5 points.

XLV. *An improper broken number is that, whose Numerator is greater then the Denominator;* As $\frac{54}{12}$ foot, that is, foure and fifty *twelves* of a foot: and indeed a broken number of this kind may well bee surnamed *Improper*, because it will not admit the definition of a true broken number, being alwaies greater then an intire *unity*: So $\frac{54}{12}$ foot is after *Reduction* 4 intire foot,

 and

and $\frac{6}{12}$ that is, six inches, as shall further appeare hereafter.

A mixt number. XLVI. *A mixt number is that which besides the Integers, or intire Unities, of which it consists, hath also a broken number annexed:* so if you would expresse in figures a length of a piece of timber, that containes twelve foot, and five and twenty hundreds of a foot, you are to write it *thus,* 12 $\frac{25}{100}$. In like manner, 24. l. 13. s. 5.d. 3.f. that is, 24. intire pounds, 13. shillings, 5. pence, 3. farthings, are *thus* exprest, 24. s. $\frac{647}{960}$ or briefly (as before) *thus,* 24. l. 13. s. 05. d. 3. f. o. yet *thus,* 24. 13. 05. 3.

Vide supra Rule 28.

XLVII. *A mixt number hath two parts, the whole, and the broken.*

XLVIII. *The whole part is, that composed of the Integers or intire unities;* as in the last examples, 12. & 24.

XLIX. *The broken part is the Fraction annexed,* as $\frac{25}{100}$ and $\frac{647}{960}$.

L. *When the Fraction annexed is a Decimall, you may expresse it without the Denominator by fixing a point betweene the whole and broken parts of the number propounded,* so 12 $\frac{25}{100}$ may be *thus* exprest, 12. .25. and 16 $\frac{5}{100}$ thus 16. 05.

CHAP.

CHAP. 2.

Of Addition.

I. A*Rithmetique is either Naturall or Artificiall.*

II. *Naturall, which is performed by the numbers themselves; and this is either Positive, or Negative.*

III. *Positive Arithmetique is that, which is wrought by certaine and infallible numbers at first propounded; and this is either single or comparative.*

IV. *Single, which is wrought by Numbers considered alone without having Relation one to another.*

V. *The parts of single Arithmetique are 1 Numeration, 2 the Extraction of Roots.*

VI. *Numeration is that which by certaine known numbers propounded, discovereth another Number unknown.*

VII. *Numeration hath foure species,* viz. *Addition and Subtraction; Multiplication and Division.* Ramus Arith. lib. 1. cap. 2. prop. 3. & 4. &c. prop. 2.

VIII. *Addition is that by which divers numbers are added together, to the end that the summe or totall may be discovered.*

 IX. *In*

Addition 1. Of whole Numbers.

IX. *In addition place the numbers given one above another in ſuch ſort, that the like degrees may ſtand in the ſame ranke:* that is, units above units, tenths above tenths &c. So the numbers 1213, and 462, being given to bee added together, you are to order them, as you ſee in the Margent:

X. *Having thus placed the numbers, and drawne a line under them, adde them together, beginning with the units firſt,* and ſaying thus, 2 and 3 make 5, which write under the line in the rank of *units:* then 6 and 1 makes 7. which write in the next place towards the left hand in the rank of *Tenths*, and ſo proceed till you have finiſhed the whole addition: which done, the *ſumme* of theſe two given numbers is 1675 and the intire *operation* will ſtand thus;

1213
462
1675

In like manner the numbers 2315, 7423, and 141, being given, their *ſumme* is 9879, and the *operation* thereof will ſtand thus:

2315
7423
141
9879

XI. *When the ſumme of the figures of any of the ranks exceeds ten, place downe under the ſame ranke the exceſſe, and for each ten that it ſo exceeds carry an unit in your mind, and adde it to the figures*

of the next ranke towards the left hand: So the numbers 54937, 9878, and 394, being given to be added together, the *operation* will ſtand thus; for 4, 8, and 7, make *nineteen*, wherefore I ſet down 9, and carrying in minde 1 for the *ten*, that it exceeds, I ſay, 1, and 9, (9 being the firſt figure of the next rank) make *ten*, which being added to 7 and 3, the other figures of the ſame rank, the whole ſumme of them is *twenty*, wherefore ſetting down a cypher under the line in that rank, (becauſe the exceſſe above two *tens* is nothing) I cary 2 to the next rank, and ſo proceeding till the whole *operation* be finiſhed, I finde the *ſumme* of the three numbers given to bee 65209, as in the example.

54937
9878
394
65209

2. Of Numbers which have divers denominations. See the latter part of the 30. Rule of the Ch. aforegoing.

XII. *When the numbers propounded to be added have divers denominations, you muſt begin with the leaſt firſt, and when the ſum of any of the denominations amounts to an Integer, adde it to the next Integers upon the left hand:* So theſe ſeverall ſummes 24, l. 13, s. 5, d. 3, f. *Item*, 12, l. 0, s. 8, d. and 5, l. 18, s 0, d. 2, f. being propounded, their totall ſumme is 42, l, 12, s. 2, d. 1, f.

l.	s.	d.	f.
24.	13.	05.	3.
12.	00.	08.	0.
05.	18.	00.	2.
42.	12.	02.	1.

For 3 and 2 farthings make *one penny farthing*, wherefore setting downe one under the denomination of farthings, I carry one *penny* to the denomination of pence: then I say, 1,8,and 5, make 14, which is 1 shilling 2 pence,wherefore writing 2 under the denomination of pence I likewise carry 1 *shilling* to the denomination of shillings: In like manner, adding the said 1 shilling unto 18 shillings and 13 shillings, the summe will be found 1 pound and 12 shillings, wherefore setting down 12 under the denomination of shillings, I carry 1 *pound* unto the denomination of pounds, and proceeding with the pounds according to the 10th and 11th *Rules* of this Chapter, at last I finde the *totall* of the three summes propounded to be 42, l. 12, s. 2, d. 1, f. as aforesaid.

In

In like manner 3, lb. 5, ounc. 19,p.15,gr. *Item* 2 lb. 0,ounc.3,p.7. gr. *Item* 0,l.10, ounc. 6,p. And 0, lb 9,ounc. 0, p. 17, gr. being given, their summe is 7, lb. 1, ounce, 9, p. 15, gr.

03.	05.	19.	15.
02.	00.	03.	07.
00.	10.	06.	00.
00.	09.	00.	17.
07.	01.	09.	15.

CHAP. 3.

Of Subtraction.

I. S*Ubtraction is that,by which one number is taken out of another, to the end that the residue or remainder may be known, which remainder is also called the Difference.* Subtraction. 1. Of whole Numbers.

II. *The number out of which the subtraction is to be made, must be greater, or at least equall with the other* : As you may subtract,4347,or 9478, out of 9478, so can you not subtract 9478, out of 4347.

III. *In subtraction rank your numbers and begin as in Addition*, that is, with the *units* first: So the numbers 9478, and 4347, being given to be subtracted the one out

out of the other, I order them as in the Margent: then proceeding to the *subtraction* I *say* 7 out of 8 there *remaines* one, which I place in the same rank under the line. In like manner

9	4	7	8
4	3	4	7
5	1	3	1

4 being taken out of 7, the *remainder* is 3, which likewise I set under the line in the next rank: And thus finishing the whole *operation* the *remainder* of 4347, taken out of 9478, will be found 5131, or the difference betweene 4347 and 9478, is 5131. As in the *example.*

IV. *When any of the figures of the number given to be subtracted is greater then the figure, out of which it is to be subtracted, you must borrow ten of the next ranke towards the left hand: and then the figure of which they are so borrowed must afterwards be esteemed an Unit lesse: wherefore in this case keeping one in your minde add it to the next figure of the number given to be subtracted, and deducting all out of the figure above it, proceed in like sort till you have finished the whole operation.*

Example, 4538, being given to be subtracted out of 8203, having placed them as before, *I say*, 8 out of 3, that cannot bee, wherefore borrowing ten of the next rank, *I say*,

I say, 8 out of 13, there *remaines* 5, then writing 5 under the line: and carrying 1 in my mind *I say*, 1, and 3, are 4, 4, out of nothing, that cannot bee, but 4 out of 10, there *remaines 6*, which I write likewise under the line, and so proceeding till the whole operation be finished, it will stand as you see it in the example.

8	2	0	3
4	5	3	8
3	6	6	5

V. *If the numbers propounded have divers denominations, when any of the parts of the greater number are lesse then the parts of the lesse number subscribed, subduct the parts of the lesser number from the parts of the greater number increased with an Integer, of the next superiour denomination, and keeping one (that is, the Integer borrowed) in your minde, adde it to the next place of the number given to be subtracted as before:* So 12, l. 0, s. 8, d. being deducted out of 24, l. 13, s. 5, d. 3, f. the remainder is 12, l. 12, s. 9, d. 3, f. for 0 being deducted out of 3, f. there *remains* 3, f. then because 8, pence cannot be taken out of 5 pence, I borrow 1, s. of the next *denomination,* 2. Of Numbers having divers denominations.

24.	13.	05.	3.
12.	00.	08.	0.
12.	12.	09.	3.

nation, which makes the 5, d. 17, d. then *I say*, 8, d. out of 17 d. there *remaines* 9, d. wherefore writing 9 under the denomination of pence, I proceed to the next *denomination*, and *say*, 0, and 1 shilling (that is the 1 shilling which was borrowed) make 1 shilling, which being deducted out of 13 shillings, the *remainder* is 12, which I subscribe under the *denomination* of shillings: Lastly, deducting 12, l. out of 24, l. at last I finde, if *A.* being indebted to *B.* in 24, l. 13, s. 5, d. 3, f. hath discharged thereof 12, l. 0, s. 8, d. there *remaines* yet undischarged 12, l. 12, s. 9, d. 3, f.

The proof of Addition and Subtraction.

VI. *Addition is proved by Subtraction, and Subtraction by Addition:* For having added divers numbers together, if you *subtract* one of them out of the summe, the *remainder* will be equall to the rest, as you may observe by the *Examples* following:

1213	54937
462	9878
	394
1675	65209
1213	64815

Here in the first *example* 462, being deducted out of 1675 the summe, the *remainder* is 1213 which is the same with the other number given to be added: So in the other *example* 394, being *subtracted* out of 65209, the *remainder* is 64815, which is equall to the summe of 54937 and 9878, the other numbers given to be added.

In like manner is *Subtraction* proved by *Addition*: for if you adde the number given to be subtracted, and the remainder together, the summe will be equall to the number, out of which the subtraction is made, as appeares by these *examples.*

9478	8203
4347	4538
5131	3665
9478	8203

CHAP. IV.

Of Multiplication.

I. M*Ultiplication is that by which we multiply two numbers the one by the other, to the end their product may be discovered.*

II. *Multiplication hath three parts, the Multiplicand, the Multiplicator, and the Product.* The parts of Multiplication.

III. *The Multiplicand is the number given to be multplied.*

IV. *The*

IV. *The Multiplicator is the number by which the multiplicand is multiplied.*

V. *The Product is the number produced by the Multiplication.* So if 5 bee given to bee *multiplyed* by 3, the third number *produced* is 15, for 3 times 5, makes 15. and here 5 is the Multiplicand, 3 the Multiplicator, and 15 the product.

VI. *Multiplication is single or compound.*

Single Multiplication. VII. *Single Multiplication is, when the multiplicand, and multiplicator consist each of them of one onely figure*, as in the last *Example* ; In like manner if you *multiply* 9 by 5. the *product* is 45. this is likewise *single* Multiplication : now the severall varieties of *single* Multiplication are well exprest in the *Table* following, usually called *Pythagoras* Table.

The

1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18
3	6	9	12	15	18	21	24	27
4	8	12	16	20	24	28	32	36
5	10	15	20	25	30	35	40	45
6	12	18	24	30	36	42	48	54
7	14	21	28	35	42	49	56	63
8	16	24	32	40	48	56	64	72
9	18	27	36	45	54	63	72	81

The use of the Table is this, Having one figure given to be *multiplyed* by another, to know the *product* of them, find the *multiplicand* in the top of the Table, and the *multiplicator* in the first column thereof towards the left hand ; this done, in the angle of *Position* just against those two figures you shall finde the *Product*. So 9 being given to be *multiplied* by 5, I find 9 in the top of the Table, and 5 in the first column toward the left hand, then in the angle of *Position*, (*viz.* in the first column towards the right hand) just against those figures I finde 45, which is the *product* required : And the particular varieties of this Table ought

ought to be learned by heart (that is, a man must know by heart the *product* of any *single* multiplication) before he can be able to work readily *compound* multiplication, as shall further appear hereafter.

Compound Multiplication.

VIII. *Compound multiplication is when the multiplicator and multiplicand either one or both consist of moe figures then one.*

IX. *In Compound multiplication when the numbers given end with significant figures, place them as in Addition, and Subtraction.* So 1232 being given to bee *multiplied* by 3, place them thus; then proceeding to the multiplication *say thus*, three times two is six, which write under the line in the ranke of your *multiplying* figure; Again *say* three times three is nine, which write likewise under the line in the next rank, and so proceed till you have finished the whole *multiplication*, which will then stand as you see it in the margent.

```
1232
   3
```

```
1232
   3
----
3696
```

X. *When the multiplicator consists of moe figures then one, for as many figures as it hath, so many severall products must be subscribed under the line, which at last being added into one summe, gives you the totall product of all.*

So

So 1232 being given to bee *multiplied* by 23, the operation thereof wil stand thus; for 1232 being *multiplied* by 3, the *product* is 3696; again 1232 being *multiplyed* by 2, the *product* is 2464, which severall *products* standing in their due order (that is the last figure of each *product* under his respective *multiplying* figure) and added together produce 28336, the *product* required: In like manner 1321 being given to be *multiplied* by 123, the *product* is 162483 and the operation will stand as you see it in the *Margent*.

```
 1232
   23
-----
 3696
2464
-----
28336
```

```
  1321
   123
------
  3963
 2642
1321
------
162483
```

XI. *When the product of any of the particular figures exceeds ten, place the excesse under the line as before, and for every ten that it so exceeds, keep one in minde to bee added to the next rank.*

Example, 3473 being given to bee *multiplied* by 64, the worke will stand thus; for 4 times 3 being 12, I write 2 under the line, and reserve 1 for the *ten*, that it exceeds, to bee added to the next rank; Then I *say* 4 times 7 is 28, unto which if I adde 1

```
  3473
    64
------
 13892
20838
------
222272
```


which

1 which I kept in mind, the whole is 29. wherefore subscribing 9 in the next rank under the line, and carrying two in mind for the two *tens*, that it exceeds, I proceed to perform the rest of the work, as you see it in the *example*.

XII. *When the numbers given to be multiplied, do one, or both of them end with cyphers, place their first significant figures towards the right hand one under another, and when the multiplication of the significant figures is finished, annexe all the cyphers after the number produced by the multiplication, which will give you the true product demanded:* As appears by the examples following:

```
   43125        43100
    1500        15000
  ------       ------
  215625        2155
  43125         431
--------    ---------
64687500    646500000
```

XIII. *When in the Multiplicator, cyphers are included between significant figures, multiply by the said significant figures, neglecting such cyphers or cypher, and observe to set each particular*

lar Product in its due place according to the 10th. rule *of this Chapter*: Examples hereof, are these following:

```
   3634          56324
    205          20006
 ------     ----------
  18170         337944
  7268        112648
 ------     ----------
 744970     1126817944
```

XIV. *When a number is given to be multiplied by a number, that consists of an unit in the first place towards the left hand, and nothing but cyphers towards the right* (*such as are* 10. 100. 1000. 10000. &c.) *the Multiplication is performed by annexing the cyphers of the Multiplicator after the figures of the Multiplicand* : So if 4057 were given to bee *multiplied* by 10000, the *product* will be found 40570000.

XV. *When moe numbers then two are given to bee multiplied together, they are said to bee multiplied continually, and this kind of multiplying is termed Continuall multiplication.* Continuall Multiplication.

So if 4, 18, and 22, were given to be *multiplied* continually; first 18 *multiplied* by 4, *produceth* 72, which being multiplied by 22, (the third number) *produceth* 1584, the last *product* or number required; the worke stands as in the *margent*.

```
   18
    4
   --
   72 pr. 1.
   22
  ---
  144
 144
 ----
 1584 pr. 2.
```

Chap. V.

Of Division.

I. D*Ivision is that by which wee discover how often one number is contained in another, to the end we may find the Quotient.*

The parts of Division.

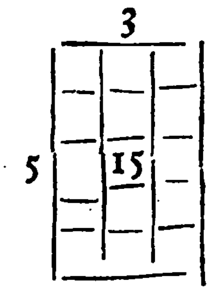
II. *Division hath three parts, the Dividend, the Divisor, and the Quotient.*

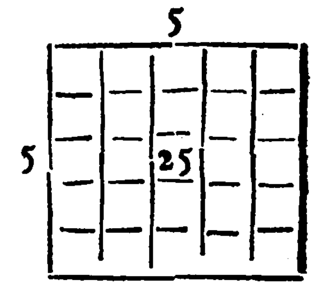
III. *The Dividend is the number given to be divided.*

IV. *The Divisor is the number, by which the Dividend is divided.*

V. *The Quotient is the number produced by the Division*: So if 15 were given to be *divided* by 5, the number produced

would be 3. for 5 is found to be three times in 15, and here 15 is the *Dividend*, 5 the *Divisor*, and 3 the *Quotient*. The reason or demonstration both of *Division* and *Multiplication* is well exprest by the *Diagrammes* following:





In the first of which you may observe, that the whole content comprehends 15 little *squares*, and therefore here 15 is the *Dividend*, 5 (one of the sides) the *Divisor*, and 3 (the other side) the *quotient*; or *vice versa*, 15 is the *Dividend*, 3 the *Divisor*, and 5 the *quotient*: for if it be demanded, how often 5 is in 15, the *Answer* is 3. or it being demanded how often 3 is in 15, the *Answer* is 5. because as the one way when you conceive five of the little *squares* to be in a rank, the number of the ranks is 3,

so the other way when you place three in a rank, the number of the ranks will then be found 5. Likewise in the other *Diagramme*, the whole content 25 is the *Dividend*, 5 the *Divisor*, and 5 the *quotient* : for 5 is found five times in 25. Again, observe that in *Multiplication* one of the sides is the *Multiplicand*, and the other the *Multiplicator*, which being multiplied, the one by the other produce the Content: So 5 being multiplied by 3 *produce* 15, and 5 being multiplied by 5 *produce* 25.

The way how to work Division.

VI. *In Division, make a crooked line at each end of the dividend, that on the left hand serving for the place of the divisor; and that on the right, for the quotient; then distinguish by a point, so many of the formost places of the dividend, as will contain the divisor; which number so set apart, may (for distinction sake) be called the dividuall:* So 2471862 being given to bee divided by 38, set a point under 7, not under 1, because fewer places will contain the *divisor*, nor under 4, because 24 is lesse then the *divisor*, so is 247 the *dividuall.*

38)2471862(

VII. *Having thus prepared the numbers, aske how often the divisor is contained in the dividuall, and place, that which answers the question in the quotient, then multiply the divisor by that particular quotient, and subtract the product from the dividuall, setting down the remainder:* Thus aske how often 38 is contained in 247, and since to answer this question, (and such like) there is a necessity of triall, it will be requisite that you fitly begin your triall, viz. If the *divisor* and *dividuall* consist of equall places, ask how often the first figure of the *divisor* towards the left hand, is contained in the first figure of the *dividuall* towards the left, but if the *dividuall* consist of one place more then the *divisor* (as here it doth) ask how often the first figure of the *divisor*, is contained in the two formost places of the *dividuall*, viz. Ask how often 3 is contained in 24, so the answer will be 8 times, which shewes that 38 cannot be found in 247 more then 8 times, and therefore begin the triall with 8, then multiplying 38 by 8 the product is 304, which being greater then 247, make triall with 7; so multiplying 38 by 7, the product is 266, which being yet greater then 247, make triall with 6; so multiplying 38 by 6, the product is 228, which being lesse then 247, shewes, that 38 may be

bee found 6 times in 247, therefore place 6 in the *quotient* and ſet down the ſaid product 228 under the *dividuall* 247; then draw a line under the product 228 and ſubduct the ſame from the *dividuall* 247, ſo is the remainder 19, and the worke will ſtand as in the *Margent*.

```
38)2471862(6
   228
   ---
    19
```

VIII. *Set a point under the next place of the dividend, and tranſcribe the figure or cypher ſtanding in that place, after the remainder, which gives you a new dividuall*: So 1 being tranſcribed after 19, the *dividuall* is 191, and the work will ſtand as in the *Margent*.

```
38)2471862(6
   228
   ---
    191
```

IX. *Renew the queſtion and proceed according to the* 7th. *rule of this Chapter*, viz. ſeek how often 38 is found in 191, and beginning the triall at 6, becauſe 3, (the firſt figure in the *diviſor*) is contained 6 times in 19, (the two formoſt places of the *dividuall*) multiply 38 by 6, ſo will the product be 228, which being greater then the *dividuall* 191, make triall with 5, and ſo the product of 38 multiplied by 5, will

be found 190, which being leſſe then 191, ſhewes, that 38 may bee found 5 times in 191, therefore place 5 in the *quotient*, and ſet down the product 190, under the *dividuall* 191, then drawing a line, and ſubducting 190 from 191, the remainder is 1, and the work will ſtand as in the *Margent*.

```
38)2471862(65
   228
   ---
    191
    190
    ---
      1
```

X. *Proceed according to the* 8th. *rule of this Chapter*: ſo will the new *dividuall* be found 18, and the work will ſtand as you ſee in the *Margent*.

```
38)2471862(65
   228
   ---
    191
    190
    ---
     18
```

XI. *Repeat the queſtion*, viz. aske how often 38 is found in 18, and here becauſe the *diviſor* 38, is leſſe then the *dividual* 18, place a cypher in the *quotient* (which is to be done in like manner as often as the *diviſor* is greater then the *dividuall*) then

```
38)2471862(650
   228
   ---
    191
    190
    ---
     186
```

then proceed according to the 8th. rule of this Chapter; so will the new *dividuall* be found 186, and the worke will stand as in the *Margent.*

XII. *Repeat the question, and proceed in every respect as before, untill the whole work be finished,* which will stand as in the *margent*, and the *quotient* required will be found 65049; And here observe, that although the first figure of the *divisor*, may sometimes bee found more then 9 times in the correspondent part of the *dividuall*, yet the whole *divisor*, cannot bee found more then 9 times, in the whole *dividuall*, and therefore you need never begin the triall above 9, in any of the operations, so in the last operation of this Example, although 3 might be found 11 times in 34, yet 38 will not be found more then 9 times in 342.

```
38)2471862(65049
   228
   ---
    191
    190
    ---
     186
     152
     ---
      342
      342
      ---
        0
```

XIII. *So often as the question is repeated in division, so many places there must be in the quotient, which may be discovered, by the number of points placed under the dividend, and so many severall operations are there in the whole worke, which you are to continue, till the last place of the dividend be transcribed.*

XIV. *When after the whole worke is finished, any figures remain of the last subtraction, they are the Numerator of a Fraction, which hath the divisor for its denominator, and is to be annexed to the quotient, as the broken part thereof, which Fraction expresseth certain parts (or at least a part) of an Integer, which is alwayes of the same denomination with the quotient*: So if 83027 crownes were to be distributed amongst 343 *Souldiers*, the part allotted to each *Souldier*, would be $242\frac{21}{343}$, that is, 242 crowns, and 21 parts of a crown being divided into 343 parts; for 83027 being divided by 343, the *quotient* is $242\frac{21}{343}$, as appears by the work; But to find the value of the said $\frac{21}{343}$ of a crown, or of any other Fraction, see the 8th.

```
343)83027(242 21/343
    686
    ----
    1442
    1372
    ----
      707
      686
      ---
       21
```

8th. Rule of the 7th. Chapter.

XV. *When the divisor consists of an Unit in the first place towards the left hand, and nothing but cyphers towards the right, the division is performed by cutting off so many places of the dividend towards the right hand, as the divisor hath cyphers; which figures so cut off are the numerator of a Fraction, which hath for the denominator the divisor given.*

So if 4720348 were given to be *divided* by 10000, the work would stand as in the *margent*, and the number required by the *division* is 472 $\frac{0348}{10000}$, or 472.0348 by the last *rule* of the first Chapter aforegoing.

472|0348

XVI. *When the divisor consists of any significant figure or figures in the first place (or more of the formost places) towards the left hand, and nothing but cyphers towards the right, cut off so many places of the dividend towards the right hand, as the divisor hath cyphers towards the right, and divide the dividend remaining on the left hand, by the remaining part of the divisor when the cyphers are omitted, remembring after the division is ended, to restore aswell the cyphers to the divisor, as the places cut off to the dividend.* So

So if 7456787 were given to be *divided* by 304000. the *quotient* would be found 24 $\frac{160787}{304000}$, for if you cut off 3 places of the *dividend* towards the right hand, (3 places because the 3 last places of the *divisor* are cyphers) and divide the remaining part of the *dividend*, viz. 7456 by 304, the whole part of the *quotient* will bee found 24; Also if unto 160 the remainder of the last subtraction, you restore the places of the *dividend* cut off towards the right hand, viz. 787, there will bee 160787 for the *numerator* of a *Fraction*, whose *denominator* is the whole *divisor*, viz. 304000.

```
304|000)7456|787(24 160787/304000
         608
        ----
         1376
         1216
        ------
          160787
```

XVII. *When the dividend is lesse then the divisor, place the dividend as the numerator of a Fraction, and the divisor as denominator, so is such Fraction the quotient sought, the value whereof (if there bee occasion) may be found by the 8th. rule of the 7th. Chapter.*

So if 3 pounds *sterling* were to bee distributed amongst 4 men, each mans share would

would be $\frac{3}{4}$l. that is (as will be manifest by the 8th. *rule* of the 7th. Chapter) 15. shillings.

Bipartition and Tripartition.

XVIII. *Two particular species of division are Bipartition and Tripartition.*

XIX. *Bipartition (otherwise called Mediation) is division by 2.*

XX. *Tripartition is division by 3.*

XXI. *In Bipartition and Tripartition, subscribe the quotient under the dividend (or where you please) not setting down at all the Divisor.*

So 82506 being given to be halfed or divided by 2, the work will stand thus; for 2 is 4 times in 8, once in 2, 2 times in 5, and then because 1 remains of 5, which makes the place of the cypher 10, I write 5 under the cypher, (2 being 5 times in 10) And last of all I place 3 under 6, 2 being found 3 times in 6.

82506	82506
41253	27502

In like manner 82506 being given to be divided by 3, do as you are directed in the other example.

The proofe of Multiplication and Division.

XXII. *Division and Multiplication do interchangeably prove one another*; for in *Division* if you multiply the *divisor* by the

quotient, the *Product* will be equall to the *dividend*: So in the example of the 12. *Rule* of this Chapter, 38. the *divisor* being multiplied by 65049 the *quotient* produceth 2471862 the *dividend*: But when after the whole *division* is finished, any figures *remain* of the last subtraction, adde them likewise to the *Product*: so in the example of the 14th. *Rule* of this Chapter, 343 being multiplied by 242, the *Product* is 83006, unto which if you adde 21, the figures remaining, the summe is 83027 the *dividend*. Againe in *Multiplication*, the *Product* being *divided* by the *Multiplicator*, the *quotient* will give you the *Multiplicand*: so in the second example of the 10th. *Rule* of the last Chapter, 162483 the *Product*, being *divided* by 123 the *Multiplicator*, the *quotient* gives you 1321 the *Multiplicand*.

To prove Division by Addition.

Division may likewise bee proved by Addition, for if the severall products arising from the Multiplication of the divisor by each particular quotient, and the remainder of the last subtraction (if there be any,) be added together in the same order of rankes as they are placed in the division, the summe will be equall to the dividend.

So

So in the example of the 14th. *Rule* of this Chapter if the severall *Products* 686, 1372,686 with the *remainder* 21 be added together in the same order of ranks as they are placed in the *division*, the summe will bee found 83027, which is the same with the *dividend*, as by the operation in the *Margent* may appeare.

```
343) 83027 (24 21/343
     686
     1442
     1372
      707
      686
       21
     83027
```

Chap. VI.

Of the Reduction of Integers from one denomination to another.

The Reduction of Integers from one Denomination to another.

I. BY *denominations* are here understood the particular *Species* of Money, Waight, Measure, Time, &c. So a pound *sterling*, a shilling, a penny, a farthing, are the particular *Species* or *denominations* of money

money used in *England*, as may appear by the 30th. *Rule* of the first Chapter: also a pound, an ounce, a penny waight, a grain, are the particular *Denominations* of *Troy* waight, as may appeare by the 31, 32, and 33 *Rules* of the first Chapter: And the like is to be understood of *Averdupois* waight, measures, time, &c. whose particular *Species* or *denominations* are expressed in the *Tables* of the first Chapter: Now albeit, the known parts of money, waight, measure, &c. are properly fractions, yet (for more commodious operation) they are esteemed and written (ordinarily) as Integers, (as may appeare by the 30. 33. 36. 37. 44 *Rules* of the first Chapter: also by the 12th *Rule* of the 2d. Chapter and the 5th. of the 3d. Chapter) And so they are esteemed in this *Rule* of *Reduction*, which serveth to reduce such kind of whole numbers or Integers from one *denomination* to another, *viz.* a greater *denomination* into a lesse, as pounds into shillings, shillings into pence, and pence into farthings, (and the like is to be understood of other *denominations*.) or else a lesser *denomination* into a greater, as farthings into pence, pence into shillings, and shillings into pounds, (and such like.)

To reduce Integers from a greater denomination to a lesse.

II. *Integers of a greater denomination are reduced into Integers of a lesse by multiplication; for if the number of Integers given, be multiplyed by the number of Integers of the denomination required, which are equall to one of the Integers given, the product is the number of Integers of the denomination required.*

So 230 pounds *sterling* are reduced into 4600 shillings, for if 230 be multiplyed by 20, (the number of shillings which are equall to a pound *sterling*) the product is 4600; In like manner 4600 shillings are reduced into 55200 pence; for if 4600 be multiplyed by 12,(the number of pence w^ch^ are equall to a shilling) the product is 55200. Also 55200 pence being multiplyed by 4, (because 4 farthings make a penny) are reduced into 220800 farthings; as by the operation in the *Margent* is manifest. The like is to bee observed in Waight, Measure, &c. So 345 Ounces *Troy* are reduced into 6900 penny

```
   230
    20
  ----
  4600
    12
  ----
  9200
 4600
 -----
 55200
     4
------
220800
```


waight, and 6900 penny waight into 165600 graines, as by the operation in the *margent* is manifest.

```
   345
    20
  ----
  6900
    24
 -----
 27600
13800
------
165600
```

To reduce Integers of divers denominations into the least of those denominations.

III. *Integers of divers denominations, are reduced into the least of those denominations according to the last Rule, by descending orderly to the next inferiour denomination, and adding to each Product such Integers (if there be any) which belong unto it.*

So 12 pounds, 13 shillings and 10 pence are reduced into 3046 pence in this manner, *viz.* 12. *li.* multiplyed by 20. *s.* produceth 240 shillings, unto which adding 13. *s.* the summe is 253 shillings: Againe 253 shillings multiplyed by 12 pence, produceth 3036 pence, unto which if

```
li.  s.  d.
12—13—10
 20
----
 240
  13
----
 253
  12
----
 506
253
----
3036
  10
----
3046
```

if 10 pence be added, the summe is 3046 pence, as by the operation in the *margent* is manifest. The like is to be observed in waight, measure, time, &c. So 35 ounces 16 penny waight and 12 graines will bee reduced into 17196. graines.

To reduce Integers from a lesser denomination to a greater.

IV. *Integers of a lesser denomination are reduced into Integers of a greater by division; for if the number of Integers given be divided by such a number of the same Integers which are equall to one of the Integers required, the quotient is the number of Integers sought.*

So 220800 farthings are reduced into 55200 pence; for if 220800 be divided by 4, (the number of farthings which are equall to a penny) the Quotient is 55200 pence; In like manner 55200 pence are reduced into 4600 shillings; for if 55200 be divided by 12, (because 12 pence make a shilling) the Quotient is 4600 shillings; Lastly, 4600 shillings being divided by 20, (because 20 shillings are equall to a pound *sterling*,) the Quotient is 230 pounds *sterling*, which are equall to 220800 farthings first given; The operation will bee as followeth,


```
            12        20
4) 220800 (55200 (460,0 (230 li.
   20       48
   --       --
    20      72
    20      72
    --      --
     08     000
     8
     --
     000
```

In like manner 34268 graines *Troy*, will bee reduced into 5 pounds, 11 ounces, 7 penny waight and 20 graines *Troy*.

If the *Learner* bee desirous onely of so much *Arithmeticall* skill as may bee sufficient for the resolution of most practicall questions which will happen in ordinary affaires or commerce, he may from this Chapter proceed next of all to the 21th. Chapter treating of the *Rule of Three*, and therein principally observe the three first *Examples*, waving all the operations of *Fractions* as well vulgar as decimall, excepting the 8th. *Rule* of the 7th. Chapter which is very necessary in division for the finding the value of the fractionall part of the quotient, (when any happens:) But if hee desire to lay a good foundation for knowledge in the *Mathematiques*, it will be requisite that he take all in order.

Chap. VII.

Of Reduction of Fractions.

I. THe ſame parts of *Arithmetique, viz*, Addition, Subtraction, Multiplication and Diviſion, which have been wrought in whole numbers by the 2. 3. 4. and 5th. Chapters, are likewiſe to be performed in broken numbers, (otherwiſe called parts or Fractions) but firſt of all, *Reduction* of *Fractions* or broken numbers in ſeverall kinds muſt bee known, which being the *Baſis* of the whole buſineſſe of *Fractions* ought to bee the more diligently obſerved, and is explained in the following rules.

See the definitions of Fractions in the 1 Chapter.

To finde the greateſt cōmon meaſure unto any two numbers.

II. *Two numbers being given, their greateſt common meaſure (that is, the greateſt number which will meaſure or divide either of the numbers given without leaving any remainder) may be found in this manner,* viz. *Divide the greater number by the leſſe, then divide the laſt Diviſor by the remainder, (if there be any) and ſo continue dividing the laſt Diviſors by the remainders untill there bee no remainder, (neglecting the quotients) ſo is the laſt Diviſor the greateſt common meaſure unto the numbers given.*

Thus, if the greateſt *common meaſure* unto the numbers 91 and 117 bee ſought, divide the greater number 117 by 91, ſo the remainder is 26, by which dividing 91, the remainder is 13, by which dividing 26, the remainder is 0; ſo is 13 the greateſt *common meaſure* unto the numbers 117 and 91, as is manifeſt in dividing each of them by 13; for 13 is found in 91 preciſely 7 times, and in 117 preciſely 9 times.

```
91) 117 (1
     91
    ----
    26) 91 (3
        78
       ----
       13) 26 (2
           26
          ----
            0
```

To reduce a Fraction into the leaſt termes, viz. 1. By a generall Rule.

III. *A ſingle Fraction may be reduced into the leaſt termes, in dividing the Numerator and denominator by their greateſt common meaſure, for the quotients will bee the Numerator and Denominator of a fraction equall to the former, and in the leaſt termes.*

So if the *Fraction* $\frac{91}{117}$ be given to be reduced into the *leaſt termes*, finde the greateſt

teſt common meaſure unto 91 and 117 by the laſt *Rule*, which will be found 13, then dividing 91 by 13, the quotient will be 7 for a new Numerator, alſo dividing 117 by 13, the quotient will bee 9 for a new Denominator, ſo is the *Fraction* $\frac{91}{117}$ reduced into the *leaſt termes*, viz. into the *Fraction* $\frac{7}{9}$: But here you are to obſerve, that if the greateſt *common meaſure* unto the Numerator and Denominator be 1, ſuch *Fraction* is in its *leaſt termes* already, ſo the *Fraction* $\frac{19}{151}$ cannot be reduced into lower termes, becauſe the greateſt *common meaſure* will bee found 1, (by the 2d *Rule* of this Chapter) the like may happen of infinite others: And although the laſt be a generall *Rule* for the Reduction of *Fractions* into their *leaſt termes*, yet there are other practicall *Rules*, which in ſome caſes will be more ready, (eſpecially unto beginners) viz.

2 By particular Rules. IV. *When the Numerator and Denominator are even numbers, they may be meaſured or divided by 2. Therefore in ſuch caſe you may (as is taught in the 21 Rule of the 5th. Chapter) take the halfe of the Numerator for a new Numerator, Alſo the halfe of the Denominator for a new Denominator.* So if $\frac{16}{64}$ bee given, draw

draw at length the line which ſeparates the Numerator from the Denominator, and croſſe the ſame with a down right ſtroke neere the *Fraction*, as you ſee in the *Margent*, then take the halfe of 16, which is 8, for a new Numerator, alſo the halfe of 64, which is 32, for a new Denominator; Againe the halfe of 8 is 4, for a new Numerator, alſo the halfe of 32, is 16, for a new Denominator, and proceeding in like manner, there will bee found $\frac{1}{4}$ equivalent unto $\frac{16}{64}$.

16	8	4	2	1
64	32	16	8	4

V. *When the Numerator and Denominator doe each of them end with 5, or one of them ending with 5, and the other with a cypher, they may be both meaſured or divided by 5.* So $\frac{225}{475}$ will bee reduced into $\frac{9}{19}$; and $\frac{50}{425}$ into $\frac{2}{17}$, as by the operation in the *Margent* is manifeſt.

225	45	9
475	95	19

50	10	2
425	85	17

VI. *Whenſoever you can eſpy any other number, which will exactly meaſure the Numerator and Denominator, (although it be not the greateſt common meaſure) you* may

may divide the Numerator and Denominator by ſuch number as before: So $\frac{28}{84}$ may be firſt reduced into $\frac{7}{21}$ by 4, and $\frac{7}{21}$ may be reduced into $\frac{1}{3}$ by 7, as by the operation is manifeſt.

28	7	1
84	21	3

VII. *When the Numerator and denominator doe each of them end with a cypher or cyphers, cut off equall cyphers in both, ſo will the fraction be reduced into leſſer termes:* So $\frac{400}{500}$ is reduced into $\frac{4}{5}$, and $\frac{700}{9000}$ into $\frac{7}{90}$.

4	00
5	00
7	00
90	00

To find the value of a ſingle fraction in the known parts of the Integer.

VIII. *The value of a ſingle Fraction in the known parts of the Integer, may be found in this manner, viz. Multiply the Numerator of the Fraction propounded, by the number of known parts of the next inferiour denomination which are equall to the Integer, and divide that product by the denominator, ſo is the quotient the value of the Fraction in that inferiour denomination, and if there happen to bee any fraction in the quotient, you may finde the value*

value thereof in the next inferiour denomination, by the ſame Rule, and ſo proceed till you come to the leaſt known parts.

So the *value* of $\frac{9}{16}$ of a pound *ſterling* will be found 11.*s.* 3 *d.* viz. multiplying the Numerator 9, by 20 (the number of ſhillings which are equall to a pound *ſterling*) the product is 180, which being divided by the denominator 16, the Quotient is 11 $\frac{4}{16}$ ſhillings. In like manner, the value of $\frac{4}{16}$ of a ſhilling will be found 3 pence, for multiplying the Numerator 4 by 12, (the number of pence in a ſhilling) the product is 48, which being divided by the denominator 16, the Quotient is 3 pence. Alſo the *value* of $\frac{7}{13}$ of a pound *ſterling* will bee found 10. *s.* $9\frac{3}{13}$ *d.* And $\frac{31}{96}$ of a pound *Troy* will be found equivalent unto 3 ounces 17 penny waight and 12 graines.

$$\begin{array}{r} 20 \\ 9 \\ \hline 16)\,180\,(11\tfrac{4}{16} \\ 16 \\ \hline 20 \\ 16 \\ \hline 4 \\ 12 \\ 16)\,48\,(3 \\ 48 \\ \hline 0 \end{array}$$

IX. *A mixt number may bee reduced into an*

To reduce a mixt number into an improper fraction.

an improper fraction equivalent unto the mixt number, in this manner, viz. Multiply the Integrall part of the mixt number, by the denominator of the Fraction annexed to the Integers, and unto the Product adde the Numerator of the said Fraction, so is the summe the Numerator of an improper fraction, whose denominator is the same with that of the said fraction annexed.

So $4\frac{11}{12}$ will be reduced into the *improper fraction* $\frac{59}{12}$, for 4 being multiplyed by 12, the Product is 48. unto which adding the Numerator 11, the summe is 59 for a new Numerator, which being placed over the Denominator 12, gives the *improper fraction* $\frac{59}{12}$, which is equivalent unto $4\frac{11}{12}$, (as will appeare by the 12th. *Rule* of this Chapter.)

To reduce a whole number into an improper fraction.

X. *A whole number is reduced into an improper fraction, by placing the whole Number given, as a Numerator, and* 1 *as a denominator.*

So 14 *Integers* will be reduced into the *improper fraction* $\frac{14}{1}$ and one *Integer* into the *improper fraction* $\frac{1}{1}$.

XI. *A whole number is reduced into an improper fraction which shall have any denominator assigned, in multiplying the whole*

whole number given, by the denominator assigned, and placing the Product as a Numerator, over the said denominator.

So if 13 be given to be reduced, into an *improper fraction* whose denominator shall be 4, multiply 13 by 4. so is the Product 52, which being placed over 4, gives the *improper fraction* $\frac{52}{4}$, equivalent unto 13, (as will appear by the next *Rule*) in like manner 13 may be reduced into $\frac{21}{7}$.

To reduce an improper fraction into its equivalent whole or mixt number.

XII. *An improper fraction may bee reduced into its equivalent whole number or mixt number, in this manner, viz. divide the Numerator by the denominator, so is the quotient the whole number or mixt number sought:* So the *improper fraction* $\frac{59}{12}$ will bee reduced into the *mixt number* $4\frac{11}{12}$, for if 59 bee divided by 12, the quotient is $4\frac{11}{12}$; Also the *improper fraction* $\frac{52}{4}$ will bee reduced into the whole number 13.

To reduce fractions to a common denominator, viz. 1. When two fractions are propounded.

XIII. *Fractions having unequall denominators, may be reduced into fractions of the same value which shall have equall denominators, by this Rule and the next following, viz. when two fractions having unequall denominators are propounded, to be reduced into two other fractions of the same value which shall have a common deno-*

denominator, multiply the Numerator of the firſt fraction, (that is, either of them) by the denominator of the ſecond, ſo is the product a new Numerator (correſpondent unto the Numerator of that firſt fraction,) Alſo multiply the Numerator of the ſecond fraction by the Denominator of the firſt, ſo is the Product a new Numerator (correſpondent unto the Numerator of the ſecond fraction) laſtly, multiply the Denominators one by the other, ſo is the Product a common denominator to both the new Numerators.

Thus if the fractions $\frac{2}{3}$ and $\frac{4}{5}$ bee propounded, multiply 2 by 5, ſo is the product 10 for a new Numerator correſpondent unto 2: alſo multiply 4 by 3, ſo is the product 12, which is a new Numerator coreſpondent unto 4: laſtly multiply 3 by 5, ſo is the product 15, which ſhall be a *common denominator* unto the new Numerators; ſo the *Fractions* $\frac{10}{15}$ and $\frac{12}{15}$ are found, which have *equall denominators* and each of theſe new *Fractions* is equall unto its correſpondent *Fraction* firſt given, viz. $\frac{10}{15}$ is equall unto $\frac{2}{3}$, and $\frac{12}{15}$ is equall unto $\frac{4}{5}$, (as will be manifeſt by the 3d. *Rule* of this Chapter.)

$$\frac{2}{3} \times \frac{4}{5}$$

$$\frac{10}{15} \qquad \frac{12}{15}$$

XIV. *When three or more fractions which have unequall denominators, are given to bee reduced as in the laſt Rule, multiply the Numerator of each fraction and all the denominators excepting its own, continually, ſo are the ſeverall products ariſing from ſuch continuall multiplication, new Numerators; Laſtly multiply all the denominators continually, ſo is the product a common denominator to all the new Numerators.*

2. When 3 or more fractions are propounded. See continuall Multiplication in the laſt Rule of the 4 Chapter.

So if the *fractions* $\frac{3}{8}$ $\frac{2}{5}$ and $\frac{5}{7}$, having unequall denominators, are given to bee reduced into three other *fractions* of the ſame value, which ſhall have *equall denominators*, multiply the Numerator 3, into the denominators 5 and 7 continually, ſo is the product 105; Alſo multiply the Numerator 2, into the denominators 8 and 7, continually, ſo is the Product 112; In like manner multiplying the Numerator 5, into the denominators 8 and 5 continually the product is 200, which 3 products are 3 new Numerators; Laſtly multiply all the denominators 8, 5, and 7 continually, ſo is the Product 280 which is *a common denominator*

minator to all the new Numerators; thus the *fractions* $\frac{105}{280}$, $\frac{112}{280}$, and $\frac{200}{280}$ are found, which have *equall denominators*, and each of these new *fractions* is equall unto its correspondent *fraction* first given, viz. $\frac{105}{280}$ is equall unto $\frac{3}{8}$, $\frac{112}{280}$ is equall unto $\frac{2}{5}$, and $\frac{200}{280}$ is equall unto $\frac{5}{7}$, as will be manifest by the third *Rule* of this Chapter.

$$\frac{3}{8} \quad \frac{2}{5} \quad \frac{5}{7}$$
$$\frac{105}{280} \quad \frac{112}{280} \quad \frac{200}{280}$$

To reduce a compound fraction to a single fraction. See continuall multiplication in the last Rule of the 4 Chapter.

XV. *A compound fraction (otherwise called a fraction of a fraction) may be reduced into a single fraction in this manner, viz. Multiply al the Numerators continually, so is the Product a new Numerator, also multiply all the denominators continually, so is the Product a new denominator.*

Thus if the *compound fraction* $\frac{2}{3}$ of $\frac{3}{4}$, be given to bee reduced into a *single fraction*, multiply the Numerators 2 and 3, one by the other, so is the product 6 for a new Numerator. Also multiplying the Denominators 3 and 4 one by the other, the product is 12 for a new denominator, so is $\frac{6}{12}$ (or $\frac{1}{2}$) the new *single fraction* sought, being equivalent unto

$$\frac{2}{3} \text{ of } \frac{3}{4}$$
$$\frac{6}{12} \Big| \frac{1}{2}$$

unto $\frac{2}{3}$ of $\frac{3}{4}$ the *compound Fraction*, given to bee reduced: In like manner the *compound Fraction* $\frac{1}{4}$ of $\frac{3}{4}$ of $\frac{4}{5}$, will be reduced into the *single Fraction* $\frac{12}{80}$ (or $\frac{3}{20}$.)

Here you may observe, that when any terme in a question belonging to any of the subsequent Chapters, is a *compound Fraction*, it is first of all to be reduced into a *single Fraction* by the last mentioned *Rule.*

To finde whole numbers which shall have the same reason as any fractions or mixt numbers given.

XVI. *Two or more Fractions being given, there may bee whole numbers found, which shall have the same Reason or Proportion as the Fractions given*, viz. *When the Fractions given have unequall denominators, reduce them into equivalent Fractions which shall have a common denominator, (by the* 13th. *or* 14th. *Rule of this Chapter) then rejecting the common denominator, the Numerators shall have the same Reason or Proportion as the Fractions first given.*

So $\frac{3}{5}$ and $\frac{5}{8}$ being given, will first of all be reduced into their equivalent Fractions $\frac{24}{40}$ and $\frac{25}{40}$, Then rejecting the common denominator 40, the Numerators 24 and 25 will have the same *Reason* with $\frac{3}{5}$ and $\frac{5}{8}$, *viz.* As $\frac{3}{5}$ is to $\frac{5}{8}$, so is 24 to 25: Also if the fractions $\frac{1}{8}$, $\frac{1}{4}$ and $\frac{1}{2}$ were given

ven, there will bee found 8, 16, and 32, which are in the ſame proportion one to the other as the fractions given: In like manner if mixt numbers bee given, there may bee whole numbers found which ſhall have the ſame *Reaſon* or *Proportion* as the mixt numbers, ſo $5\frac{2}{3}$ and $3\frac{5}{8}$ being given, will bee firſt reduced into the improper fractions $\frac{17}{3}$ and $\frac{29}{8}$ (by the 9th. Rule of this Chapter:) Alſo the ſaid $\frac{17}{3}$ and $\frac{29}{8}$ will bee reduced into $\frac{136}{24}$ and $\frac{87}{24}$, then rejecting the common denominator 24, the Numerators 136 and 87 will have the ſame *Reaſon* as $5\frac{2}{3}$ and $3\frac{5}{8}$, viz. As 136 is to 87, ſo is $5\frac{2}{3}$ to $3\frac{5}{8}$: Alſo $16\frac{1}{2}$ and 18 being given, there will bee found 33 and 36, which reduced into their loweſt termes (by the 2d Rule of this Chapter) will bee 11 and 12 which have the ſame *Reaſon* as $16\frac{1}{2}$ and 18.

CHAP.

CHAP. VIII.

Of Addition of Fractions and mixt numbers.

To adde ſingle fractions. viz. 1. When they have equall denominators.

I. *When the termes given to bee added are ſingle Fractions and have a common denominator; adde all the Numerators together, ſo is the ſumme the Numerator of a Fraction, whoſe denominator is the ſame with the common denominator, which new Fraction is the ſumme of the Fractions given to be added.*

So $\frac{3}{9}$ and $\frac{2}{9}$ being given to bee added, their *ſumme* will bee found $\frac{5}{9}$; *viz.* the *ſumme* of the Numerators 3 and 2, is 5, which being placed over the common denominator 9, gives $\frac{5}{9}$: In like manner the *ſumme* of theſe *Fractions* $\frac{2}{8}$, $\frac{5}{8}$, $\frac{3}{8}$ and $\frac{7}{8}$ will bee found $\frac{17}{8}$, which (by the 12th. *Rule* of the 7th. Chapter) will be found equivalent unto $2\frac{1}{8}$, ſo that $2\frac{1}{8}$ is the *ſumme* of the *Fractions* given to be added.

2. When they have unequal denominators.

II. *When the Fractions given to bee added have not a common denominat, or they are firſt to bee reduced into Fractions of the ſame value which ſhall have a common*

 deno-

denominator (by the 13^{th}. *or* 14^{th}. *Rule of the* 7^{th}. *Chapter) and then they may bee added by the first Rule of this Chapter.*

So if $\frac{2}{3}$ and $\frac{3}{5}$ were given to bee added, their *summe* will bee found $1\frac{4}{15}$; for (by the 13^{th}. Rule of the 7^{th}. Chapter) $\frac{2}{3}$ and $\frac{3}{5}$ will be reduced into their equivalent fractions $\frac{10}{15}$ and $\frac{9}{15}$, which having equall denominators may be added according to the last Rule, and so the *summe* will bee found $1\frac{4}{15}$: In like manner the *summe* of these *Fractions* $\frac{1}{2}$, $\frac{3}{8}$, and $\frac{3}{4}$ will bee found $1\frac{5}{8}$.

$$\frac{2}{3} \times \frac{3}{5}$$

10

9

$\frac{19}{15}$ that is $1\frac{4}{15}$

The Addition of compound fractions.

III. *When any of the Fractions given to bee added is a compound Fraction, such compound Fraction is first of all to be reduced into a single Fraction by the* 15^{th}. *Rule of the* 7^{th}. *Chapter, and then you may proceed as before.*

So $\frac{3}{5}$, and $\frac{2}{3}$ of $\frac{1}{4}$ being given to bee added, their *summe* will bee found $\frac{23}{30}$ Here you may observe, that the *fractions* given to bee added in all the former cases, are supposed to bee fractions of Integers which have one and the same *particular denomi-*

denomination, viz. if one of the *fractions* given to bee added, bee a *fraction* of a pound *sterling*: all the rest are also to be fractions of a pound *sterling*, and the like is to bee understood of other denominations.

See what is meant by denominations in the 1 Rule of the 6 Chap.

To adde fractions of Integers which have different denominations

IV. *When fractions of Integers of different denominations are given to be added, they are first of all to be reduced into fractions of Integers which shall have one and the same particular denomination (by the* 15^{th}. *Rule of the* 7^{th}. *Chapter) and then they may bee added by the* 1^{t}. *or* 2^{d}. *Rule of this Chapter.*

So if $\frac{7}{9}$ of a pound *sterling*, $\frac{3}{5}$ of a shilling, and $\frac{5}{8}$ of a penny were given to be added, reduce the two latter into *fractions* of a pound *sterling* by the 15^{th}. *Rule* of the 7^{th}. Chapter *viz.* $\frac{3}{5}$ of a shilling is $\frac{3}{5}$ of $\frac{1}{20}$ of a pound *sterling*, which *compound fraction* being reduced into a *single fraction*, gives $\frac{3}{100}$ *li.* Likewise $\frac{5}{8}$ of a penny, is $\frac{5}{8}$ of $\frac{1}{12}$ of $\frac{1}{20}$ of a pound *sterling*, which *compound fraction* being reduced, gives $\frac{1}{384}$ *li.* Lastly $\frac{7}{9}$ *li.* $\frac{3}{100}$ *li.* and $\frac{1}{384}$ *li.* being added according to the 2^{d} *Rule* of this Chapter, the *summe* will bee found $\frac{23339}{28800}$ *li.*

To adde mixt numbers.

V. *When mixt numbers are given to be added, finde first of all the summe of the*

fractions by the 1st. *or* 2d. *Rule of this Chapter, then adde the Integer or Integers (if there bee any found) in the ſumme of the fractions, unto the whole numbers and collect the ſumme of them as you were taught by the* 10th. *and* 11th. *Rules of the* 2d. *Chapter.*

So if $3\frac{1}{2}$, $4\frac{1}{3}$, and $16\frac{5}{8}$ were given to be added, their *ſumme* will be found $24\frac{11}{24}$; *viz.* the *ſumme* of the fractions $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{5}{8}$ will bee found (by the 2d. Rule of this Chapter) to bee $1\frac{11}{24}$, and the *ſumme* of the whole number 3, 4, and 16, is 23, unto which adding 1 (the Integer found in the ſumme of the fractions) the *ſumme* is 24, ſo that $24\frac{11}{24}$ is the *ſumme* of the mixt numbers given to be added.

CHAP. IX.

Of Subtraction of Fractions and mixt numbers.

The ſubtraction of ſingle fractions viz. 1. When they have a common denominator.

I. W*Hen the termes given are both ſingle fractions and have a common denominator, ſubtract the leſſer numerator from the greater, and place the remainder over the common denominator, ſo is ſuch new fraction the difference between the fractions given.*

Thus

Thus the difference betweene the fractions $\frac{9}{11}$ and $\frac{7}{11}$, is $\frac{2}{11}$; Alſo the difference between the fractions $\frac{11}{21}$ and $\frac{17}{21}$, is $\frac{6}{21}$.

2 When they have unequall denominators.

II. *When the termes given are both ſingle fractions and have not a common denominator, reduce them into fractions of the ſame value which ſhall have a common denominator (by the* 13th. *or* 14th. *Rule of the* 7th. *Chapter) and then find their difference by the laſt Rule.*

So the *difference* between the *fractions* $\frac{6}{7}$ and $\frac{7}{8}$, will be found $\frac{1}{56}$, *viz.* reducing the *fractions* given, into their equivalent *fractions* $\frac{48}{56}$ and $\frac{49}{56}$ which have a common denominator, the *difference* ſought will be found $\frac{1}{56}$, by the firſt *Rule* of this Chapter.

The ſubtraction of mixt numbers. *viz.* 1 By a generall Rule.

III. *When one of the termes given is a whole number or a mixt number, alſo when both of them are mixt numbers, reduce ſuch whole, or mixt numbers into an improper fraction or fractions, by the* 9th. *or* 10th. *Rule of the* 7th. *Chapter, and then the operation will be according to the* 1. *or* 2d. *Rule of this Chapter.*

So $7\frac{3}{5}$ being given to be ſubtracted from 12, the *remainder* will be found $4\frac{2}{5}$; Alſo $9\frac{1}{2}$ being given to be ſubtracted from

$12\frac{1}{5}$, the *remainder* will be found $2\frac{7}{10}$; as by the subsequent operation is manifest.

$$\begin{array}{ll} 12 & 7\frac{3}{5} \\ \frac{12}{1} & \frac{38}{5} \\ 60 & \\ 38 & \\ \frac{22}{5} \text{ that is } 4\frac{2}{5}. & \end{array} \qquad \begin{array}{ll} 12\frac{1}{5} & 9\frac{1}{2} \\ \frac{61}{5} & \frac{19}{2} \\ 122 & \\ 95 & \\ \frac{27}{10} \text{ that is } 2\frac{7}{10} & \end{array}$$

Although the 3 last *Rules* bee sufficient for all cases in *subtraction* of *fractions*, mixt numbers, or whole and mixt, neverthelesse the following *Rules* will bee more expeditious in the subtraction of mixt numbers, or whole and mixt, especially when the *Integrall part* consists of many places, as will be manifest by the operation, *viz.*

2 By particular Rules viz. 1 A whole number from a mixt number.

IV. *When a whole number is given to bee subtracted from a mixt number, subtract the said whole number from the whole part of the mixt number (as is taught by the* 3ᵈ. *and* 4ᵗʰ. *Rules of the* 3ᵈ. *Chapter) and unto the remainder annex the fractionall part of the mixt number given, so is the mixt number thus found the remainder or difference sought.*

As

As if 7 bee given to bee subtracted from $24\frac{5}{8}$ the *remainder* will be $17\frac{5}{8}$ as by the operation is manifest.

$$\begin{array}{r} 24\frac{5}{8} \\ 7 \\ \hline 17\frac{5}{8} \end{array}$$

2. A fraction from an Integer.

V. *When a fraction is given to bee subtracted from an Integer, subtract the Numerator from the denominator, and place that which remaines over the Denominator, which new fraction thus found, is the remainder or difference sought.*

So $\frac{3}{5}$ being subtracted from an *Integer* or 1, the *remainder* is $\frac{2}{5}$: Also $\frac{13}{19}$ being subtracted from 1, the *remainder* is $\frac{6}{19}$.

3. A fraction from a whole number greater then 1.

VI. *When a fraction is given to be subtracted from a whole number greater then* 1, *subtract the said fraction from one of the Integers given (by the last Rule) so the remaining Fraction being annexed to the number of Integers lessened by unity or* 1, *gives the remainder or difference sought.*

Thus $\frac{5}{7}$ being subtracted from 17, the *remainder* is $16\frac{2}{7}$: Also $\frac{7}{12}$ being subtracted from 39, the *remainder* is $38\frac{5}{12}$.

4 A mixt number from a whole number.

VII. *When a mixt number is given to be subtracted from a whole number, subtract first of all (by the* 5ᵗʰ. *Rule of this Chapter) the fractionall part of the mixt*

number

number, from an Integer borrowed from the whole number given, and set down the remaining fraction, then adding the Integer borrowed, unto the Integers of the mixt number, subtract the said summe from the whole number given, (as is taught in subtraction of whole numbers) so that which remaines, together with the remaining fraction before found, is the remainder or difference sought.

So if $9\frac{7}{12}$ be subtracted frõ 50, the *remainder* is 40 $\frac{5}{12}$, as by the operation is manifest.

$$\begin{array}{r} 50 \\ 9\frac{7}{12} \\ \hline 40\frac{5}{12} \end{array}$$

5. A fraction from a mixt number by this and the next Rule.

VIII. *When a fraction is given to bee subtracted from a mixt number, and the said fraction is lesse then the fractionall part of the mixt number, subtract the lesser fraction from the greater by the 1st. or 2d. Rule of this Chapter, so the remaining fraction being annexed to the whole part of the mixt number, gives the remainder or difference sought.*

So $\frac{5}{9}$ being subtracted from $12\frac{7}{8}$, the *remainder* is $12\frac{23}{72}$, as

$$\begin{array}{r} 12\frac{7}{8} \\ 0\frac{5}{9} \\ \hline 12\frac{23}{72} \end{array}$$

by

by the operation is manifest.

IX. *When a fraction is given to bee subtracted from a mixt number, and the said fraction is greater then the fractionall part of the mixt number, subtract the said greater fraction from an Integer borrowed from the mixt number, (by the 5th. Rule of this Chapter) and adde the remaining fraction unto the fractionall part of the mixt number (by the 1st. or 2d. Rule of the 8th. Chapter) so the fraction found by that addition, being annexed to the whole part of the mixt number lessened by an Integer, or 1, gives the remainder or difference sought.*

Thus $\frac{5}{9}$ being subtracted from $13\frac{3}{8}$, the *remainder* is $12\frac{59}{72}$, *viz.* subtracting $\frac{5}{9}$ from 1, the remainder is $\frac{4}{9}$ which added to $\frac{3}{8}$ gives $\frac{59}{72}$, which being annexed to 12 (the number of *Integers*, in the mixt number lessened by 1 or unity) gives $12\frac{59}{72}$ the *remainder* sought.

$$\begin{array}{r} 13\frac{3}{8} \\ 0\frac{5}{9} \\ \hline 12\frac{59}{72} \end{array}$$

X. *When a mixt number is given to be subtracted from a mixt number, and the fractionall part of the mixt number to bee subtracted, is lesse then the fractionall part of the mixt number from which you are to* 6. A mixt number from a mixt number by this and the next Rule.

sub-

subtract, subtract the said lesser fraction from the greater, (by the 1^{t}*. or* 2^{d}*. Rule of this Chapter) and set down the remaining fraction: also subtract the Integers of the lesser mixt number from the Integers of the greater (as in Subtraction of whole numbers) so is the mixt number thus found, the remainder or difference sought.*

So if $17\frac{3}{8}$ bee given to be subtracted from $20\frac{5}{7}$, the *remainder* will bee found $3\frac{19}{56}$; *viz.* subtracting $\frac{3}{8}$ from $\frac{5}{7}$, the *remainder* is $\frac{19}{56}$, Also subtracting 17 from 20 the remainder is 3.

$$\begin{array}{r} 20\frac{5}{7} \\ 17\frac{3}{8} \\ \hline 3\frac{19}{56} \end{array}$$

XI. *When a mixt number is given to bee subtracted from a mixt number, and the fractionall part of the mixt number to be subtracted, is greater then the fractionall part of the mixt number from which you are to subtract, subtract the said greater fraction from an Integer borrowed from the greater mixt number (by the* 5^{th}*. Rule of this Chapter) and adde the remaining fraction unto the fractionall part of the lesser mixt number (by the* 1^{t}*. or* 2^{d}*. Rule of the* 8^{th}*. Chapter) so is the summe to be reserved as the fractionall part of the remainder*

remainder sought; then adde the Integer borrowed, unto the Integers of the lesser mixt number, and subtract the summe from the Integers of the greater mixt number, (as in Subtraction of whole numbers) so that which remaines, together with the fraction before reserved, is the remainder or difference sought.

Thus if $20\frac{7}{8}$ be given to be subtracted from $35\frac{2}{5}$, the *remainder* will bee found $14\frac{29}{40}$; *viz.* subtracting $\frac{7}{8}$ from an *Integer* or 1, the *remainder* is $\frac{1}{8}$, which added to $\frac{3}{5}$ gives $\frac{29}{40}$, then adding the *Integer* borrowed, unto 20, it will bee 21, which subtracted from 35, the *remainder* is 14, so that the *remainder* or *difference* sought is $14\frac{29}{40}$.

$$\begin{array}{r} 35\frac{2}{5} \\ 20\frac{7}{8} \\ \hline 14\frac{29}{40} \end{array}$$

When you cannot cleerly discerne which is the greater of two *fractions*, having unequall denominators, reduce them into *fractions* of the same value which shall have a common denominator, by the 13^{th}. *Rule* of the 7^{th}. Chapter, and then it will be apparent. **To discerne the greater of 2 fractions.**

CHAP.

CHAP. X.

Of Multiplication of Fractions and mixt numbers.

To multiply single fractions.

I. W*Hen the termes given to bee multiplyed are both single fractions, multiply the numerators one by the other, so is the product a new numerator: Also multiply the denominators one by the other, so is the product a new denominator, which new fraction is the product sought:*

So $\frac{7}{12}$ and $\frac{5}{8}$ being given to be multiplyed, the *product* will be found $\frac{35}{96}$: Also $\frac{5}{7}$ and $\frac{3}{7}$ being multiplied one by the other, the *product* will will bee found $\frac{15}{49}$. Here you may observe, that in multiplication of *Fractions*, the *Product* is always lesse then either of the termes given, for in *multiplication*, as unity or 1 is to either of the termes given, so is the other terme to the *product*.

To multiply mixt numbers.

II. *When one of the termes given is a whole number or a mixt number; Also when both of them are mixt numbers, reduce such whole number or mixt number or numbers into an improper fraction or fractions by the* 9th. *or* 10th *Rule of the* 7th *Chapter, and then the operation will be the same as in the last Rule.*

So $8\frac{2}{3}$ being given to be multiplyed by 5, the *Product* will be found $43\frac{1}{3}$; *viz.* $8\frac{2}{3}$ being reduced into an improper *fraction* will bee $\frac{26}{3}$: Also 5 will bee $\frac{5}{1}$, then multiplying 26 by 5, the *Product* is 130 for a new numerator: Also multiplying 3 by 1, the *Product* is 3 for a new denominator, which new *Fraction* $\frac{130}{3}$ being reduced (according to the 12th. *Rule* of the 7th. Chapter) will bee $43\frac{1}{3}$ the *Product* sought. In like manner $7\frac{1}{2}$ being multiplyed by $5\frac{3}{5}$, the *Product* will bee found 42. Here observe, that when either of the termes given is a *compound Fraction* it is first of all to bee reduced into a *single Fraction*, and then the operation is as before.

Other *Rules* might be prescribed for the multiplication of mixt numbers, but because the operation by such *Rules*, would be little or nothing briefer then the operation by the last *Rule*, it would be superfluous to expresse them.

CHAP.

Chap. XI.

Of Division of Fractions and mixt numbers.

The division of single Fractions.

I. W*Hen the termes given are both single fractions, multiply the denominator of the Divisor by the numerator of the Dividend, so is the product a new numerator: Also multiply the numerator of the Divisor by the denominator of the Dividend, so is the product a new denominator, which new fraction is the quotient sought.*

So if $\frac{4}{9}$ bee given to be divided by $\frac{3}{5}$, the *quotient* will bee found $\frac{20}{27}$; *viz.* multiplying 5 by 4 the product is 20 for a new numerator, also multiplying 3 by 9, the product is 27 for a new denominator, so is $\frac{20}{27}$ the *quotient* sought; In like manner if $\frac{5}{8}$ bee given to bee divided by $\frac{2}{7}$, the

Divisor	Dividend
$\frac{3}{5}$	$\frac{4}{9}$

$\frac{20}{27}$ quotient

quotient will be found $2\frac{3}{16}$, as by the operation in the *Margent* is manifest.

$$\frac{2}{7} \quad \frac{5}{8}$$

$\frac{35}{16}$ that is $2\frac{3}{16}$.

Here you may observe that in *Division* by *Fractions*, the *quotient* is alwayes greater then either of the *Fractions* given; for in *Division*, As the *Divisor* is to unity or 1, so is the *Dividend* to the *quotient*.

The division of mixt numbers.

II. *When one of the Termes given is a whole number or a mixt number; Also when both are mixt numbers, Reduce such whole number or mixt number or numbers into an improper Fraction or Fractions, by the 9th. or 10th. Rule of the 7th. Chapter, and then the operation will be the same as in the last rule.*

So if 42 be divided by $7\frac{1}{2}$, the *quotient* will be found $5\frac{3}{5}$, as by the operation in the *Margent* is manifest.

$$7\tfrac{1}{2} \quad 42$$

$$\frac{15}{2} \quad \frac{42}{1}$$

$\frac{84}{15}$ that is $5\frac{3}{5}$

In like manner if $6\frac{1}{2}$ be divided by $3\frac{2}{5}$, the *quotient* will be found $1\frac{31}{34}$. Also if $5\frac{1}{3}$ be divided by $12\frac{1}{2}$ the quotient will bee found $\frac{32}{75}$. Here observe, that when either of the Termes given is a *compound Fraction*, it is to be reduced into a *single Fraction*, and then the operation will be as before.

CHAP. XII.

Of the reduction of vulgar Fractions into Decimalls.

I. THat which hath been performed b *vulgar Fractions* in the 8th, 9th, 10th. and 11th. Chapters, may be also effe- cted with farre more conveniency and fa- cility by *decimall Fractions*; (as will b manifest in the following Chapters) whos excellent use in *Arithmetique* in generall but especially in the Doctrine of *plain Triangles*, and the practicall part of *Ge- ometry*, is well known to such who are ex- ercised in *Calculations*: Now to the end that questions which are totally or in par composed of *vulgar Fractions*, may be re- solved by *decimalls*, the way of reducing *vulgar Fractions* to *decimalls* is first to b known, which this chapter principally aim at. The invention of *decimall Arithme- tique* writes not many yeares; and since th first invention thereof, time and practic hath added much perfection thereunto: di vers challenge the first invention of it, how truely I know not; The truth is, there is no man much verst in *Calculations*, but must needs upon some occasion or other fall upon it: for my part I confesse the first light I received of that way, was out of *Ramus* in the Extraction of the square and cube roots; for by annexing Cyphers unto the square and cube numbers, the bro- ken parts of the roots are converted into *Decimals*, *ipso facto*; as you shall here- after be taught by the 19th. *Rule* of the 17th. Chapter, and by the 22th. *Rule* of the 18. chapter of this present booke.

See the definitions of Decimalls in Chap. I.

Ram. Geom. l. 12. Elem. 8. & l. 24. Elem. 6.

Of the Reduction of vulgar Fractions to Decimalls, viz. 1 Single Fractions.

II. *A single Fraction which is no Decimall, may be reduced to a Decimall of the same value, or infinitely neere by Division; For if unto the Numerator of the Fraction propounded, Cyphers at pleasure be annexed, and the whole be divided by the Denominator, the quotient is the decimall required.*

So $\frac{5}{8}$ being propounded to be reduced to a *decimall* will be changed into .625. that is $\frac{625}{1000}$, for annexing Cyphers unto the Numerator 5. it will be 5000. &c which being divided by the *Denominator* 8, the quotient will be 625, before which, prefixing a point, it will be .625. (that is $\frac{625}{1000}$) the *decimal* sought: Also $\frac{1}{4}$ will bee reduced into the *decimal* .25, (or $\frac{25}{100}$) and $\frac{2}{7}$ into

to .2857,&c. or $\frac{2857}{10000}$ almost, for $\frac{2}{7}$ cannot be converted into a *decimal* exactly equall unto it, and the like will happen in the *Reduction* of most vulgar *Fractions* to *decimals*, but by the continuall annexing of Cyphers unto the Numerator as before, you may approch infinitely neare. Here you are to observe that in reducing a vulgar *fraction* to a *decimal*, it sometimes fal[ls] out, that the first place, or more of the formost places of the *decimal* found, will be[e] cypher or cyphers, which may be discovered by the next *Rule*, *viz.*

III. *If in the Reduction of a Fractio[n] to a decimal according to the last rule, th[e] place of units in the Divisor at the first de[mand], extend unto the first of the cypher[s] annexed as before, the first figure in th[e] quotient will be tenths*, (viz. *the first pla[ce] of the decimal sought* ;) *but if it exte[nd] unto the* 2d. *cypher, the first figure in th[e] quotient will be hundreds*, (viz. *the seco[nd] place of the decimall sought*) *and in su[ch] case one cypher is to be prefixed* ; *if un[to] the third cypher, two cyphers are to b[e] prefixed*, &c.

So $\frac{19}{20}$ will bee reduced into the *decim[al]* .95 ; Also $\frac{3}{80}$ will bee converted into th[e] *decimal* .0375 ; Likewise $\frac{1}{240}$ will be[e] reduc[ed]

reduced into the *decimal* .00416, &c.

IV. *When a compound Fraction is given to bee reduced to a Decimall, reduce first of all such Compound Fraction into a single Fraction, by the* 15th. *Rule of the* 7th. *Chapter, and afterwards such single Fraction into a decimal according to the second and third rules of this Chapter.* 2. Compound Fractions.

So $\frac{13}{24}$ of $\frac{1}{20}$ of $\frac{1}{12}$ (which may represent 13 graines *Troy* waight) being propounded to be reduced to a *Decimal*, will be changed into .00225, &c. For first of all the said compound Fraction will bee reduced into the single Fraction $\frac{13}{5760}$ and afterwards the said single Fraction into the *decimal*, .00225,&c.

In like manner *Astronomicall* or *Sexagenary Fractions* may bee reduced into *Decimals*, for since a *Degree* is usually divided into sixtie *Minutes* or *Primes* : 1 *Prime* or *Minute* into sixtie *Seconds* : 1 *Second* into sixtie *Thirds* : 1 *Third* into 60 *Fourths*,&c.and consequently a *Degree* is equall to sixtie *Minutes* or *Primes*, or 3600 *Seconds*, or 216000 *Thirds*, or 12960000 *Fourths*, &c. Therefore 7 *Minutes* or *Primes*, are $\frac{7}{60}$ *Degree*, which(by the second *Rule* of this Chap.)

 may

may be reduced into the *Decimal*, ·1166, &c. Also 29 *Thirds* are $\frac{29}{216000}$ *Degree*, which will be reduced into the *Decimal*, ·000134, &c. Moreover, 58′ 33″ 14‴ 12⁗: that is, 58 *Primes*, 33 *Seconds*, 14 *Thirds*, and 12 *Fourths* may be reduced to a *decimal* in this manner, *viz.* Reduce them all into *Fourths*, (according to the third *Rule* of the sixth chapter) so will you finde 12647652 *Fourths*, or $\frac{12647652}{12960000}$ *degree*, which according to the 2 *Rule* of this chap. will be reduced into the *decimal*, ·975899, &c.

V. *Upon the foresaid ground is framed the ensuing* Table, *by helpe whereof the* Fractions *or* knowne parts *of* Money, Waight, Measure, &c. *are reduced into* Decimals, *to the end they may bee made more apt for operation, and such which have much practice in* Astronomicall Calculations *may make* Tables *for the Reduction of* Sexagenary Fractions *into* Decimals, & contra.

Moreover you may observe, that although the *decimals* in most of the *Tables* hereafter explained, consist of 7 or 8 Figures, yet in ordinary practice, you shall for the most part have occasion to use onely the first 6, and sometimes fewer.

The TABLE of REDUCTION.

English Coine.	
Sh. 19	95
18	9
17	85
16	8
15	75
14	7
13	65
12	6
11	55
10	5
9	45
8	4
7	35
6	3
5	25
4	2
3	15
2	1
1	05

D.	11	04583333
	10	04166667
	9	0375
	8	03333333
	7	02916667
	6	025
	5	02083333
	4	01666667
	3	0125
	2	00833333
	1	00416667
F.	3	003125
	2	00208333
	1	00104167

Troy Waight.

O.	11	91666667
	10	83333333
	9	75

8	66666667
7	58333333
6	5
5	41666667
4	33333333
3	25
2	16666667
1	08333333
P. 19	07916667
18	075
17	07083333
16	06666667
15	0625
14	05833333
13	05416667
12	05
11	04583333
10	04166667
9	0375
8	03333333
7	02916667
6	025
5	02083333
4	01666667
3	0125
2	00833333
1	00416667

*Gr.*23	00399305
22	00381944
21	00364583
20	00347222
19	00329861
18	003125
17	00295139
16	00277778
15	00260417
14	00243056
13	00225694
12	00208333
11	00190972
10	00173611
9	0015625
8	00138889
7	00121528
6	00104166
5	00086805
4	00069444
3	00052083
2	00034722
1	00017361

Averdupois

Averdupois great waight.

3. *qu.*	75
2. *qu.*	5
1. *qu.*	25
lb. 27	24107142
26	23214285
25	22321428
24	21428571
23	20535714
22	19642857
21	1875
20	17857143
19	16964286
18	16071428
17	15178571
16	14285714
15	13392857
14	125
13	11607143
12	10714286
11	09821428
10	08928571
9	0803[illegible]714
8	07142857

7	0625
6	05357143
5	04464286
4	03571428
3	02678571
2	01785714
1	00892857
*Ou.*15	00837053
14	0078125
13	00725446
12	00669643
11	00613839
10	00558035
9	00502232
8	00446429
7	00390625
6	00334821
5	00279018
4	00223214
3	00167411
2	00111607
1	00055804
3. *qu.*	00041853
halfe	00027902
1. *qu.*	00013951

Averdupois

Averdupois little waight.

Ou.	15	9375
	14	875
	13	8125
	12	75
	11	6875
	10	625
	9	5625
	8	5
	7	4375
	6	375
	5	3125
	4	25
	3	1875
	2	125
	1	0625
Dr.	15	05859375
	14	0546875
	13	05078115
	12	046875
	11	04296875
	10	0390625
	9	03515625
	8	03125
	7	02734375
	6	0234375
	5	01953125
	4	015625
	3	01171875
	2	0078125
	1	00390625
3. qu.		00292969
halfe		00195312
1. qu.		00097656

Liquid Measures.

Pi.	7	875
	6	75
	5	625
	4	5
	3	375
	2	25
	1	125
	3/4	09375
	1/2	0625
	1/4	03125

Drie

Drie Measures.

Bu.	7	875
	6	75
	5	625
	4	5
	3	375
	2	25
	1	125
Pec.	3	09375
	2	0625
	1	03125
	3/4	0234375
	1/2	015625
	1/4	0078125
Pi.	3	0058594
	2	0039063
	1.	0019531

Long Measures, the Integers being yards and els.

qu.	3	75
	2	5
	1	25
nail.	3	1875
	2	125
	1	0625
39 m.		046875
halfe		03125
1 qu.		015625

Time.

mo.	11	916667
	10	833333
	9	75
	8	666667
	7	583333
	6	5
	5	416667
	4	333333
	3	25
	2	166667
	1	083333
dai.	30	082193
	29	079454
	28	076714
	27	073973
	26	071233
	25	068495

			Dozens.	
24	065755		De. 11	9166667
23	063016		10	8333333
22	060274		9	75
21	057536		8	6666667
20	054795		7	5833333
19	052055		6	5
18	049316		5	4166667
17	046577		4	3333333
16	043837		3	25
15	041097		2	1666667
14	038357		1	0833333
13	035617		Pa. 11	076388
12	032877		10	0694444
11	030137		9	0625
10	027397		8	0555555
9	024657		7	0486111
8	021918		6	0416667
7	019178		5	0347222
6	016438		4	0277778
5	013698		3	0208333
4	010959		2	0138889
3	0082192		1	0069444
2	0054795			
1	0027397			

VI. *The*

The Tablet 1. Of English money.

VI. *This Table aforegoing consists of nine severall Tablets, of which the first (intituled English money) contains in the first Columne thereof the particular Fractions* (viz. *the shillings, pence, and farthings) of a pound Sterling ; and in the other Columne the decimalls, unto which they may be respectively reduced* : So in the same Tablet 65 is the *decimall*, answerable to 13, s. 02083333 to 5, d. and 003125 to 3, f.

2. Of Troy waight.

VII. *The next Tablet (intituled Troy waight) contains in the first Columne thereof the particular Fractions,* (viz. *the Ounces, Penny waights, and graines) of a pound Troy, and in the other their respective decimalls :* So 66666666 is the correspondent *decimall* of 8 ounces, 05833333 of fourteen penny waight, and 00208333 of 12 graines.

3. Of Averdupois great waight.

VIII. *The third Table (intituled Averdupois great waight, contains in the first Columne thereof the Fractions* (viz. *the Quarters, Pounds, Ounces, and quarters of Ounces) of a Hundred according to Averdupois waight, and in the other their proper decimalls :* So 5 is the *decimall* of two quarters or half a hundred, 15178571 of 17 pounds; 00334821 of 6 Ounces,

and

and 00041853 the *decimall* of 3 quarters of an Ounce.

4. Of Averdupois litle waight.

IX. *The fourth (intituled Averdupois litle waight) sheweth you the Fractions* (viz. *the Ounces, drams, and quarters of drams*) *of a pound Averdupois, together with their respective decimalls*: So the *decimall* of three Ounces is 1875, the *decimall* of 9 Drammes is 03515625, and the *decimall* of one quarter of a Dram is 00097656.

5. Of liquid Measures.

X. *The fifth (intituled Liquid measures) hath the Fractions* (viz. *the Pints, and quarters of pints*) *of a Galion, and likewise their severall decimalls*: So the *decimall* of five Pints is 625, and the *decimall* of two quarters or halfe of a Pint is 0625.

6. Of Dry Measures.

XI. *The sixth (intituled Dry measures) gives you the Fractions*, (viz. *the Bushels, Peckes, quarters of Peckes and pintes*) *of a quarter, together with their peculiar decimalls*: So 375 is the *decimall* of three Bushels, 03125 of one Pecke, 0234375 of $\frac{3}{4}$ of a Pecke, and 0039063 of two Pints.

7. Of Long Measures.

XII. *The seaventh (intituled Yards and Els) offers you the Fractions* (viz. *the Quarters, Nailes, and quarters of Nails*) *of Yards or Els, and their respective decimalls*: So 125 *is the decimall* of one quarter of a Yard or Ell, 125 of two Nailes, and 046875 of three quarters of a Naile.

8. Of Time.

XIII. *The eighth (intituled Time) presents unto you the Fractions* (viz. *the Moneths and Dayes*) *of the Yeare, together with their decimalls*: So 5833333 is the *decimall* of seaven moneths, and 043837 of 16 dayes.

9. Of things accompted by the Dozen.

XIV. *The ninth and last Tablet (intituled Dozens) yields you the Fractions*; (viz. *the dozens and particulars, of a grosse, as also their respective decimalls*: So 25 is the *decimall* of 3 Dozen, and 0486111 of 7 Particulars.

The Vse of the same Table for the Reduction

1. Of single Fractions to Decimals.

XV. *When a single Fraction of any of the premised Tablets is propounded to bee reduced to a decimall, finde it in the first Columne of the Tablet, unto which it belongs; this done, just against that Fraction so found, you shall have the decimall required*: So 13, s. being propounded, taking the last premised *Table*, I finde 13, s. in the first Columne of the Tablet of *money*, and just against the same thirteen shillings, I *observe* 65, before which having prefixed a point, and by that meanes signed it for a *decimall* (according to the twenty fifth Rule of the first Chapter of this

this Booke) I conclude the same .65 so ordered, to be the correspondent *decimall* of thirteen shillings the fraction propounded: In like manner .0019097 is the *decimall* of 11 Grains in the Tablet of *Troy* waight; and .035714 the *decimall* of 4 lb. in the Tablet of *Averdupois great waight*, &c.

XVI *When two or more fractions are propounded, and it is required to finde a decimall equivalent unto the summe of them, finde the decimall of each of the fractions given according to the last Rule; then adding together the decimals so found, that intire summe is the decimall sought:* So 13,s. 5 d. being reduced to a *decimall*, is .670833; for the *decimall* of 13,s. is .65 and the *decimall* of 5, d. .020833, which being added together (by the 2 rule of the 13 Chapter of this Booke) amount to .670833, *viz.* the *decimall* which represents 13, s 5, d. the fraction propounded: In like manner the *decimall* of 5 Ounces, 9 penny waight, and 13 Grains is .45641, and the *decimall* of $\frac{1}{2}$ C. 19, lb. 7 Ounces is .67354, &c.

13, s.	.65
5, d.	.020833
	.670833

5, ounces.	.41666
9, p. w.	.0375
13, gr.	.00225
	.45641

$\frac{1}{2}$ C.	.5
19. lb.	.16964
7. ounc.	.00390
	.67354

And here as you see meere fractions reduced, so likewise may the fractions of mixt numbers be reduced to *decimalls*: for example, these numbers 97, lb. 7, ounces. 13 $\frac{1}{4}$ dramme. *Item* of 67 Gallons, $\frac{3}{4}$ pints. *Item* 28 Quarters, 0, Bushell, 2 $\frac{1}{2}$ Pecks, and 3 Pints after reduction are 97, 4891. 67. 71875, and 28. 078.

97.4375	67.625	28.0625
.0507	.0937	.0156
.0009	67.7187	28.0781
97.4891.		

Again, 22 $\frac{1}{2}$ yards, 3 $\frac{1}{4}$ Nailes; *Item* 17 yeares:9 moneths, and 22 dayes; *Item* 36 Grosse, 3 Dozen and 5 particulars, being reduced, are 22 .7031, 17 .8102, 36 .2847.

22. 5		
.1875	17 .75	36 .25
.0156	.06027	.0347
22.7031	17.81027	36 .2847

3. Of Decimals to Single Fractions.

XVII. *When a decimall is propounded to know what Fraction it represents, search the same decimall in the second Columne of the Tablet, unto which it belongs, where if you finde it expresly, the number just against it in the first Columne is the fraction you looke for*: So .65 (representing the fraction of a pound *sterling*) being given, I finde it in the *second Columne* of the Tablet of *Money*, and over against it in the first *columne* I finde 13,s. which is the fraction represented by .65, the *decimall* propounded. In like manner 3 .0024 (representing 3 lb. and.0024 of a pound *Troy*) being propounded, the number represented by it, is 3. lb. o, Ounc. o, p 14 graines.

XVIII. *When in the second columne of the Tablet, unto which you are directed, you cannot precisely finde the decimall propounded, search that, which being lesse, comes neerest unto it, and take the number that answers unto it in the first columne for the greatest fraction of the number required: then deducting the decimall so found out of the decimall given, finde likewise the remainder, as another decimall, and take his correspondent number for the next fraction of the number required; And so proceed in that order, till you have discovered the intire number represented by the decimall propounded.*

Example: .6739 being propounded, I demand the fraction of a pound *Sterling* represented by it; The decimall in the Tablet of *money*, which being lesse comes nearest to .6739 is .65, whose correspondent number in that Tablet is 13, which are the *shillings* of the number required; Then subtracting (by the 1 *Rule* of the 14 Chapter of this Booke) .65 out of .6739, the remainder is 0239, and the nearest decimall in the same Tablet to.0239 is .0208, whose correspondent number is 5, which are the *pence* of the number required: Last of all deducting .0208 out of.0239, the *remainder* is .0031, which gives you in the first co-

Again, 22 $\frac{1}{2}$ yards, 3 $\frac{1}{4}$ Nailes; *Item* 17 yeares: 9 moneths, and 22 dayes; *Item* 36 Grosse, 3 Dozen and 5 particulars, being reduced, are 22 .7031, 17 .8102, 36 .2847.

22. 5		
.1875	17 .75	36 .25
.0156	.06027	.0347
22 .7031	17 .81027	36 .2847

3. Of Decimals to Single Fractions.

XVII. *When a decimall is propounded to know what Fraction it represents, search the same decimall in the second Columne of the Tablet, unto which it belongs, where if you finde it expresly, the number just against it in the first Columne is the fraction you looke for*: So .65 (representing the fraction of a pound *sterling*) being given, I finde it in the *second Columne* of the Tablet of *Money*, and over against it in the first *columne* I finde 13,s. which is the fraction represented by .65, the *decimall* propounded. In like manner 3 .0024 (representing 3 lb. and .0024 of a pound *Troy*) being propounded, the number represented by it, is 3. lb. 0, Ounc. 0, p. 14 graines.

XVIII. *When in the second columne of the Tablet, unto which you are directed, you*

you cannot precisely finde the decimall propounded, search that, which being lesse, comes neerest unto it, and take the number that answers unto it in the first columne for the greatest fraction of the number required: then deducting the decimall so found out of the decimall given, finde likewise the remainder, as another decimall, and take his correspondent number for the next fraction of the number required; And so proceed in that order, till you have discovered the intire number represented by the decimall propounded.

Example: .6739 being propounded, I demand the fraction of a pound *Sterling* represented by it; The decimall in the Tablet of *money*, which being lesse comes nearest to .6739 is .65, whose correspondent number in that Tablet is 13, which are the *shillings* of the number required; Then subtracting (by the 1 *Rule* of the 14 Chapter of this Booke) .65 out of .6739, the remainder is 0239, and the nearest decimall in the same Tablet to .0239 is .0208, whose correspondent number is 5, which are the *pence* of the number required: Last of all deducting .0208 out of .0239, the *remainder* is .0031, which gives you in the first co-

lumne 3, being the *farthings* of the number required: So that I conclude the intire fraction represented by the *decimall*. .6739, is 13, s. 5, d. 3, f.

13, s. 5, d. 3, f.	.6739
	.65
	.0239
	.0208
	.0031

In like manner 7. 359, C. being reduced by the Tablet of *Averdupois great waight* is 7 $\frac{1}{4}$ C. 12, lb. 4, ounc. And 94. .58, lb. reduced by the Tablet of *Averdupois little waight*; is 94, lb. 9, ounces 6 drammes.

7, C. 1, qu. 12, lb. 4, ounc.	7.359
	25
	109
	107
	002
94, lb. 9, ounc. 6, dram.	94. 58
	56
	02

XIX.

To finde the value of a Decimall by multiplication.

XIX. *Any decimall being propounded, the value thereof in the known parts of the Integer, may be found without help of the Table of Reduction,* viz. *by Multiplication; for if the decimall given be multiplied (according to the Rules of decimall Multiplication expressed in the* 15. *Chapter) by the number of known parts of the next inferiour denomination, which are equall to the Integer, the Product is the value of the decimall proposed, in that inferiour denomination; and if there happen to be any decimall in the Product, you may in like manner finde the value thereof in the next inferiour denomination, and so proceed till you come to the least known parts of the Integer.*

So if the *decimall* ·7365 representing the fraction of a pound *sterling* be propounded, the value thereof will be found 14, s. 8, d. 3, f. *fere, viz,* multiplying the *decimall* .7365 by 20 (the number of the shillings in a pound *sterling*) the Product will be found 14 .73 *shillings*. Againe, multiplying the *decimall* ·73 *shillings*, by 12 (the number of pence in a shilling) the Product will bee 8. 76 *pence*. Lastly, multiplying the *decimall* ·76. d. by 4 (the number of farthings in a

 penny)

penny) the Product wil bee found 3, 04 *farthings*. As by the operation in the *Margent* is manifest. In like manner the value of the *decimall* ·7362 of a pound *Troy* will be found 8 Ounces, 16 penny waight, and 16 Graines *fere*, as by the subsequent operation is manifest.

```
 ·7365
    20
 ------
14|7300
    12
 ------
   146
   73
 ------
  8|76
     4
 ------
  3|04
```

```
          ·7362
             12
          -----
          14724
          7362
          -----
Ounc.     8|8344
             20
P. w.    16|6880
             24
          -----
          27520
         13760
          -----
Gr.      16|5120
```

In

In like manner the decimall ·975899 degree will be reduced into $58^{\prime}:33^{\prime\prime}:14^{\prime\prime\prime}$,&c. that is, 58 minutes, 33 seconds, 14 thirds.

CHAP. XIII.
Of Notation and Addition of Decimals.

I. THe *Notation of Decimals* is before shewne in the 24, 25, 26 and 27. *Rules* of the 1 Chapter; but for the better understanding of the practical operations in *decimals*, you may further observe that the order of places in *decimals* is from the left hand to the right, contrary to that of *whole Numbers* which is from the right hand to the left, as will bee manifest by the subsequent *Table*.

I H G F E D C B A *a b c d e f g h*
9 8 7 6 5 4 3 2 1 .1 2 3 4 5 6 7 8

Ten	10	.1 Signifieth $\frac{1}{10}$
One hundred	100	.01 that is $\frac{1}{100}$
	1000	.001
	10000	.0001
	100000	.00001
	1000000	.000001
	10000000	.0000001
	100000000	.00000001

The

The Capitall letters at the head of the precedent *Table* doe shew the Order of the places of *Integers*; viz. from the place of *Vnits* to the left hand; so *A* is the place of *Units* or first place, *B* the place of *Tens*, or second place, *C* the place of *Hundreds* or third place, &c. And on the contrary, the small Romane letters doe shew the Order of the places of *Decimals* beneath Unity; so *a* is the first place, or place of *Tenths*, *b* is the second place or place of *Hundreds*, &c. And as the *valors* of the places of *Integers* doe increase in a decuple *Ratio* from Unity towards the left hand, *viz.* *B* or the second place is ten times greater in value then *A* the first place; also *C* or the third place is tenne times greater in value then *B* &c So on the contrary, the *valors* of the places of *decimals*, doe decrease in a decuple *Ratio* beneath Unity towards the right hand, *viz.* *a* or the first place of *decimals* is tenne times lesse in value then 1 or Unity, *b* or the second place is ten times lesse in value then *a*, and *c* is ten times lesse in value then *b*, &c.

Moreover, as Cyphers in the foremost places of *decimals*, are sometimes necessary to discover the true Denominator (as is

manifest by the precedent *Table*, and by the 26 *Rule* of the first Chapter:) So on the contrary, cyphers at the end of *decimals* are of no use. (*viz.*) .3 is equivalent unto .30, or .300, or .3000, (as is manifest by the 7 rule of the 7 chapter) for $\frac{30}{100}$ being reduced to its least termes will be $\frac{3}{10}$ also $\frac{3000}{10000}$ will be reduced to $\frac{3}{10}$: The premisses being considered, and the 24, 25, 26, 27, and 50th. rules of the 1 Chapter diligently observed for the writing downe of *decimals*, there will bee no difficulty in *Addition* of *decimals*, or mixt numbers whose Fractionall parts are *decimals*, as will be manifest by the subsequent *Rule*, *viz.*

II. *Place the decimals in rankes orderly one under the other in such manner, that like places may stand in one and the same down right line, which shall rightly bee done, if the points prefixed before each decimall stand directly one above another; Then adde them together as is taught in Addition of whole Numbers by the* 10th. *and* 11th. *Rules of the second Chapter: Examples hereof are these that follow:* Addition of Decimals.

	·3	25·35	32·
	·752	19·13	19·
	·098	9·073	54·
	·05	6·7	8·75
.65	·926	·05	·198
.0208	·83	24·17	·97
·6708	2·956	84·473	114·918

Here you may obſerve, that the Number of Tens (if there be any) contained in the firſt place of the *decimals*, being that next unto the points) is the Number of *Integers* to be carried to the place of *Vnits* or *Integers*.

CHAP. XIV.

Of Subtraction of Decimals.

Subtraction of Decimals

I PLace the decimals as is directed in the laſt Chapter, and then proceed as you are taught in Subtraction of whole Numbers by the third and fourth Rules of the third Chapter:

Examples

Examples hereof are theſe that follow:

Out of	·8372	295·094
Take	·7842	78·919
Rem.	·0530	216·175

But here when the *decimals* conſiſt not of equall places towards the right hand, ſupply that defect by annexing Cyphers, or at leaſt by ſuppoſing Cyphers to bee annexed unto thoſe *Decimalls*, in that kinde deficient: Examples hereof are theſe;

.65	24.04338
.04338	.65
60662	23.39338

37·	·3944
·10416	·35
36·89584	·0444

CHAP.

CHAP. XV.

Of Multiplication of Decimals.

Multiplication of Decimals.

I. IN *any of the Cases which may fall out in Multiplication of decimals, multiply the Termes given as if they were whole Numbers, according to the Rules prescribed in the fourth Chapter, and cut off alwayes from the Product towards the right hand by a downright line or point, so many places as are jointly in the decimall parts of both the terms given to be multiplied; so is the number cut off toward the right hand the Fractionall part of the Product, and that on the left hand (if any happen) is the Integrall part of the Product: Examples hereof are these that follow:*

12.453	246.25
7.08	35
99624	123125
87171	73875
88|16724	861875
564	·87
·9	·9
507|6	·783

II. *When*

II. *When the Product consists not of so many places as there are places of decimall parts in both the Termes given, (which oftentimes may happen when the Product is a decimall) supply the deficient place or places in the Product, with a Cypher or Cyphers prefixed on the left hand thereof: Examples hereof are these following:*

5.525	.0375	.0125
.0026	.05	.025
33150	.001875	625
11050		250
0143650		.0003125

CHAP. XVI.

Of Division by Decimals.

I. IN *any of the Cases which may happen in division by decimals, the dividend being greater then the divisor, the quotient will be either a whole Number or a mixt Number; but being lesse then the divisor, the quotient will be a decimall.*

II. *Cyphers at pleasure (if there bee occasion) are to be annexed, or at least supposed to be annexed to the dividend, to the*

end

end that the quotient may bee continued to as many places as is neceſſary.

III. *The dividend being ſo prepared, you are to divide it by the diviſor as if they were whole Numbers, according to the rules preſcribed in the 5 Chapter, and to ſever the whole part of the quotient; (if there be any) from the fractionall or broken part, or elſe to finde the quality of the fractionall part, when there is not any Integer in the quotient, according to the following Rules.*

Diviſion by Decimalls, *viz.* 1. When both the Termes are mixt Numbers, or one of them a whole Number and the other mixt, or when the Dividend is a Decimall and the Diviſor a whole or mixt Number.

IV. *The Termes given being both mixt Numbers, or one of them a whole Number and the other a mixt Number, or the dividend being a decimall and the diviſor a whole Number or a mixt number; the firſt figure in the quotient (in ſuch Caſes) will be of the ſame place or degree, with that Figure or Cypher of the dividend which at firſt demand ſtandeth, or at leaſt is ſuppoſed to ſtand directly over the place of Vnits in the diviſor.*

So if 1524.25 be divided by 28.75, the *quotient* will be found 53.0173, &c. for the place of *Tens* in the *dividend* (that is the ſecond place of the *Integers* towards the left hand) ſtanding over the place of *Vnits* in the *diviſor*, (that is, the firſt

firſt place of the *Integers*) at the firſt demand, ſhewes that the firſt Figure in the *quotient* will bee in the place of *Tens*, and therefore the *Integrall part* of the *quotient* muſt conſiſt of two of the formoſt places, and the reſt will bee a *decimall*: In like manner if 5.3672 bee divided by 17, the *quotient* will bee found .3157, &c. For the place of *Tenths* (or firſt place of a *decimall*) in the *dividend*, ſtanding over the place of *Vnits* in the *diviſor*, (that is, over the firſt place of the *Integers*,) at the firſt demand, ſhewes that the firſt Figure of the *quotient*, will bee the place of *Tenths*, (or firſt place of a *decimall*:) Alſo if 1 or an *Integer* bee divided by 26. 3, the *quotient* will bee .038, &c. And if .35673 bee divided by 44, the *quotient* will bee .0081, &c. The operation of the ſaid examples will be as followeth:

```
28.75)1524.250000(53.0173,&c.
      1437 5
        8675
        8625   17)5.3672(.3157.
           5000     51
           2875      26
          21250      17
          20135      97
          11250      85
           8625     122
           2625     119
                      3

26.3)1.0000(.038,&c.   44).35673(.0081,&c.
     789                   352
     2110                   47
     2104                   44
        6                    3
```

2. When the Dividend is a whole Number or mixt.

V. *When the dividend is a whole or mixt Number and the divisor a decimal, observe how many places will arise in the quotient, in dividing the whole part of the dividend increased on the right hand with so many places as are in the divisor, for the same Number of places will be in the Integrall part of the quotient in this Case.*

So

So if 19 : 35 bee divided by .032, the *quotient* will be found 604 . 6875, for if unto 19 the *whole part* of the *dividend* be annexed three places (being the Number of places in the *divisor*) it will consist of 5 places, in dividing whereof by 32 the significant figures in the *divisor*, it is manifest there will arise three places in the *quotient*, which shewes that the *Integrall part* of the *quotient* will consist of three places: Also if 2481 be divided by ·25, the *quotient* will bee 9924. The operation of the said examples will be as followeth;

```
.032) 19.3500000 (604.6875
      192
        150
        128
         220   ·25)2481.00(9924
         192       225
          280       231
          256       225
           240        60
           224        50
            160       100
            160       100
              0         0
```

I. VI.

3. When the Termes given are Decimals, the Dividend being the greater Terme.

VI. *When the Termes given are both decimals, the dividend being the greater, observe how many places will arise in the quotient, in dividing so many of the formost places of the dividend, as there are places in the divisor, for the same number of places will be in the Integrall part of the quotient in this Case.*

So if 4375 be divided by ·03, the *quotient* will be 14 ·583, &c. Also if ·6880 be divided by ·32· the *quotient* will be 2,15. The operation will be as followeth.

.03). 43750(14|583, &c.

```
32).6880(2|15
     64
     --
     48
     32
     --
     160
     160
     ---
       0
```

4. When the Termes given are Decimals, the Dividend being the lesser Terme.

VII. *When the Termes given are both decimals consisting of equall places, the dividend being the lesser Terme, place the dividend as a Numerator, and the divisor a denominator, so is such vulgar Fraction the quotient; But if the Termes given consist not of equall places, supply the place or places defective in either of the Termes, by annexing a Cypher or Cyphers on the right hand, and then proceed as before.*

So if . 25 be propounded to be divided by .75 the *quotient* will be $\frac{25}{75}$. Also if . 3 be given to be divided by ·9654 the *quotient* will be $\frac{3000}{9654}$, which *vulgar Fractions*, (if occasion serve) may bee reduced into *decimals* by the second Rule of the 12 Chapter.

Chap. XVII.

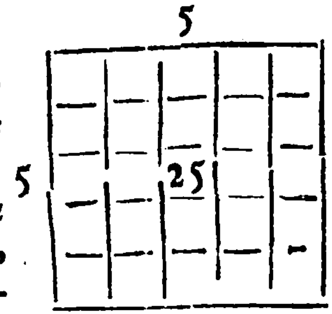
The Extraction of the Square Roote.

I. T*Hus much of* Numeration. *Now followes the* Extraction *of* Roots, viz. *of the* Square *and* Cube.

II. *The* Extraction *of the* Square-root *is that by which having a Number given wee finde out another Number, which being multiplyed by it selfe produceth the number given.*

III. *In the* Extraction *of the* square-root *the Number propounded is alwayes conceived to bee a* Square*number*, *that is, a number of certain little* Squares

A Square number.



comprehẽded within one intire great square, *and the* Roote *or number required is the side of that great* Square. What the Extraction of the *Square roote* is, will readily appeare by this *Diagramme*, before produced in the 5 rule of the 5 Chapter: For as in *Multiplication* having two *sides* given, we demand the *Content*, and in *division* having the Content, and one of the sides propounded, the other *side* is required: So in the Extraction of the *Square root* having a *Square content* given, we demand the *side*, which being *multiplyed* by it selfe constitutes that *Square*: Thus the *Square number* 25 being given (as in the *Diagramme*) his *roote* demanded is 5, for 5 times 5 is 25.

IV.

IV. Square numbers *are either* single or compound.

V. *A* single Square number *is that, which being produced by the* multiplication *of one single figure by it selfe, is alwayes lesse then* 100. So 25 is a *single Square number* produced by 5, multiplyed by it selfe.

A single square number.

VI. *All the* single Square numbers *together with their respective* rootes *are expressed in the* Table *following*;

1	4	9	16	25	36	49	64	81
1	2	3	4	5	6	7	8	9

Here in the uppermost rank of the Table are placed the *single* Square numbers of every particular *figure*, and in the other their respective *roots*; And therefore if it were demanded what is the *Square roote* of 36, the *Answere* would bee 6. so the *square roote* of 4 is 2, the *square roote* of 9 is 3, &c.

VII. *When a* Square number *is given, that exceeds not* 100, *and yet is none of the* Square numbers *mentioned in the* Table, *for his* roote *you are to take the* roote *of the*

the Square number, *that being lesse, yet comes nearest unto it*: So 45 being given, the *roote* that belongs unto it is 6, and 10 being given, his correspondent *roote* is 3.

A Compound square number.

VIII. *A Compound* Square number *is that, which being produced by a* number *(that consists of mo places then one) multiplied by it selfe, is never lesse then* 100. So 1024 is a *Compound* square number produced by the multiplication of 32 multiplied by it self.

IX. *To prepare any* Square number *given for* Extraction, *subscribe a Point under each other figure beginning with the last first*: So 1024 being given, you are to subscribe the *Points* thus, 1024. And so many *Points* as are in that manner subscribed, of so many figures the *roote* demanded will consist.

The Extraction.

X. *Having thus prepared your number, you may see it distributed by the points into severall* Squares: So in the last example 10 is the first *Square*, and 24 the second.

XI. *Having drawn a quotient in the margent, finde the* roote *of the first square, and place it in the quotient*: So I finding by the seventh rule aforegoing 3, to be the cor-

correspondent *roote* of 10, I write 3 in the quotient, and then the worke will stand *thus*, 1024 (3.

XII. *Subscribe the square of the figure placed in the Quotient under the first square of the number given, as you see in the Margent.*

1024 (3
9

XIII. *Subtract the square of the figure placed in the quotient, out of the* 1. *square of the number given, and having placed the remainder above that first square, cancell the figures out of which the Subtraction was made*: this done, the worke will stand as it is in the *Margent.*

1
~~10~~24 (3
9

XIV. *Draw a line under the worke, and having doubled the* roote, *place it under the first figure of the next square*: As in the *example.*

XV. *Demanding how often the first Figure of the double* roote *towards the left hand is contained in the remaining figures of the square Number placed above it, and observing in that behalfe the Rules before taught in Division,*

1
~~10~~24 (3
9
6

vision, write the Answer in the Quotient, as also under the line after the double roote: So if you aske how often 6 is in 12. the *Answer* is 2. wherefore I write 2 in the *Quotient*, and likewise under the *line* after 6. See the Example in the *Margent*.

See the 5. Chapter.

```
      1
  1024(32
   9
  ---
   62
```

XVI. *Multiply the number under the line by the Figure last placed in the Quotient, and writing the Product under that number, Subtract it out of the Figures of the Square number placed above it, and then proceed as you are directed in the* 13th *Rule aforegoing.*

So 62 multiplied by 2, the Product is 124, which if I *Subtract* out of 124 the Figures of the *Square number* placed above it, the *remainder* is 0. And thus the whole worke being finished, the *Square root of* 1024, the number propounded, is found to be 32.

```
  100
 1024(32
   9
  62
  124
```

But here observe by the way, that when the Product exceeds the number placed above it, the worke is erroneous, and then you are to reform it by placing a lesse Figure

See the 5. Chapter.

Figure in the quotient, as you were taught before in *Division*.

XVII. *When after the whole worke is finished, any Figures remaine of the last Subtraction, they are the Numerator of a Fraction, which hath the* roote *doubled with an Vnite added unto it for his denominator, and is to bee annexed unto the number in the Quotient, as the broken part of the* roote *required.*

So if the *Square roote* of 43623 were demanded, it would be found 208 $\frac{359}{417}$ as appeares by the *Example* hereunto annexed, for having distinguished the number given into severall *Squares* by Points, first I demand the *Square roote* of 4 the *first* square, which I finde by the *sixth* rule of this Chapter to bee 2, wherefore placing 2 in the *Quotient*, and 4 the *Square* thereof under 4 the *first* square, I *subtract* 4 out of 4, and finding nothing to remain I *cancell* 4 the *first* square, placing 0 above it; then drawing a *line* under the worke, I *double* 2 the roote, and place the double thereof, *viz.* 4. under

```
 00359
 43623 (208 359/417
 4
 -----
  40
 -----
   408
  3264
```

under 3 the first Figure of the *next* square; after this I demand how often 4 the *double* roote is contained in 3 the *figure* placed above it, and not finding it once contained in it, I place 0 in the Quotient, (according to the 11th. rule of the 5th. Chap.) and likewise under the line after the *double roote*; and because the Product of 40 multiplied by 0 (the last Figure placed in the Quotient) is 0, 36 the *figures* out of which it ought to bee deducted remain the same without *alteration*; wherefore *drawing* another line, and doubling 20 the roote, I *place* 40 the double roote under 2 the *first* figure of the *last* square; then I *demand* again how often 4 the *first* figure of the *double* roote is contained in 36 the figures above it; and though it bee *nine* times in it, yet dare I take but 8, which I write in the Quotient (according to the 7. rule of the 5. Chapter) and likewise after 40 under the *lowest* line; This done, I multiplying as before 408 the number under the *line* by 8 the *last* figure placed in the Quotient, the product is 3264, which if I *subtract* out of 3623 the figures placed above it, the *remainder* is 359; So that at last I finde 208 to be the whole part of the *roote* demanded; and as for the *Fraction*

Fraction annexed 359 is the *Numerator* thereof, and 417 the *denominator*; For 208 the roote being doubled is 416, whereunto if you adde an *unite* (according to this rule) the summe is 417; and therefore the *Number* sought for in this demand is 208 $\frac{359}{417}$ as before in the *Example*.

XVIII. *The extraction of the Square* roote *is proved by multiplying the* roote *by it selfe*; for that done the product will be equall to the number *given*; So in the first *example* of this Chapter, 32 being multiplied by it selfe produceth 1024, the number *propounded*; But when the Quotient hath a fraction annexed, adde the *numerator* of that fraction to the product, and then the summe will bee equall to the number *given*: So in the last *Example* 208 being multiplied by it selfe produceth 43264, unto which if you adde 359, the *Numerator* of the fraction annexed, the summe is 43623 the Number *propounded*. The Proof.

XIX. *Sometime to finde the broken part of the* roote *more exactly, a competent number of paires of Cyphers, viz. either* 00, 0000, 000000, *or* 00000000, *&c. are annexed unto the number given, and in* Ram. Geom. lib. 12. Elem. 8.

in this Case the said broken part of the roote *is alwayes a decimall consisting of so many places as there were paires of Cyphers annexed.*

So if 43623 were given, as before, to finde the roote thereof (according to this Rule) annexe Cyphers unto it in this manner, 4362300000, And then if you ex-

```
    2550
  0035956O4
  4362300000 (208. 861.
  .  .  .  .  .  .
  4
   40
    408
   3264
     4168
    33344
      41766
     250596
       41772
```

tract it according to the *rules* aforegoing you shall finde the roote thereof to bee 208.861, which is *equivalent* to 208 $\frac{359}{417}$ for the *whole* parts are the same in both the

the *rootes*, and as for the *broken* parts $\frac{359}{417}$ and $\frac{861}{1000}$ or .861 have the same value; the whole operation is apparent by the *example* premised. *Again*, if 10 were propounded to bee extracted, you must prepare it thus, 100000000000000, and then the roote thereof in this manner extracted will bee,

$$3\frac{1622776}{10000000}$$

which may also bee written thus, 3. 1622776 according to the last rule of the 1 chapter of this Booke.

```
      117
     1394456
     1000000000 &c. (3.162,&c.
      .   .   .
     9
      61
       626
      3756
        6322
       12644
```

See here part of the worke which may give you a light and understanding of the rest: And here *observe* that in this case the more *Cyphers* you annexe unto the number

ber given, the more just and exact the *operation* will prove.

Lastly, as touching the *Points*, by which the number given ought to bee marked, proceed as you are before directed in the 9 rule of this Chapter (beginning *first* with the *last* Figure of the number given) as though no *Cyphers* at all were annexed; and then subscribe likewise *Points* under each other of the *Cyphers* annexed, proceeding from the *last* Figure of the number given towards the *right* hand: See the examples.

To extract the square roote of a Fraction.

XX. *The* Square roote *of a Fraction is found in this manner, viz. extract the* Square roote *of the* Numerator (*according to the aforegoing Rules of this chapter*) *which* roote *shall bee a new* Numerator. *Also the* Square roote *of the denominator is a new denominator, so is the new Fraction the* Square roote *of the Fraction given :*

Thus the *Square roote* of $\frac{9}{16}$ is $\frac{3}{4}$, *viz.* the *Square root* of 9 is 3 for a new Numerator; Also the *Square roote* of 16 is 4 for a new denominator.

Of Fractions incommensurable to their square roots.

XXI. *When either the Numerator or denominator hath not a perfect* Square root, *viz. when such Fraction is incommensurable to its* square roote, *the* square root *of such Fraction is expressed by prefixing this Character* $\surd$ *or* $\surd q.$ *before the Fraction given :*

So the *square roote* of $\frac{13}{16}$ is thus expressed $\surd\frac{13}{16}$, or *thus* $\surd q\,\frac{13}{16}$ because it is inexpressible by number: But here you are to observe, that if the *Fraction* whose *square roote* is required, be not in its *least Termes*; it is first of all to be reduced into its *least Termes* by the 3 *Rule* of the 7. chapter; for oftentimes it happens, that although the former be *incommensurable* to its *roote*, yet the latter may bee *commensurable*; So in this *Fraction* $\frac{8}{18}$ each Tearme is *incommensurable* to its *square roote*, but the said $\frac{8}{18}$ being reduced to its *least Termes* $\frac{4}{9}$, there will be found in each Terme a *commensurable roote*; *viz.* the *square roote* of 4 is 2 for a new Numerator, and the *square roote* of 9 is 3 for a new Denominator, so is $\frac{2}{3}$ the *square roote* of $\frac{4}{9}$ (equivalent unto $\frac{8}{18}$.)

To extract the square root neare, of a Fraction incommensurable to its square roote.

XXII. *The* square roote *of a Fraction which is incommensurable to its* roote *may be found neare, in this manner, viz. Reduce the Fraction proposed into a decimall by the* 2 *Rule of the* 12 *Chapter: the more places are in the decimall, the nearer will the* roote *be found, but the decimall must*

must consist of an even number of places, viz. either of two, foure, six, eight or ten, &c. places ; Then extract the square root *of that decimall as if it were a whole number according to the Rules aforegoing, which* roote *found shall bee a decimall expressing neare the* square roote *of the fraction proposed.*

So if the *square roote* of $\frac{13}{16}$ bee required neare, reduce the said $\frac{13}{16}$ into a Decimall (by the 2. *rule* of the 12. Chapter) which will be found .81250000, &c. Then extracting the *square roote* thereof as if it were a whole number, it will bee found .9013 *ferè.*

To extract the square roote of a mixt number.

XXIII. *The* square roote *of a mixt number commensurable to its* roote, *is found in the same manner as in the 20. rule of this Chapter, the mixt number being first reduced into an improper Fraction by the 9. rule of the 7. chapter.*

So the *square roote* of $34\frac{33}{64}$ will bee found $5\frac{7}{8}$ viz. $34\frac{33}{64}$ being reduced into the improper fraction $\frac{2209}{64}$, the *square root* of the Numerator 2209 will be 47 for a new Numerator ; Also the *square roote* of the Denominator 64 is 8, for a new Denominator, so is found $\frac{47}{8}$ which (by the 12. rule of the 7. Chapter) is $5\frac{7}{8}$ the *square roote*

roote sought. And here the same Caution is to be observed as in the 21. *Rule* of this Chapter; *viz.* the fractionall part of the mixt number, or the improper fraction equivalent unto the mixt number, must be in the *least Termes* before any extraction be made.

To finde the Square root neare, of a mixt Number incommensurable to its roote.

XXIV. *When the mixt number given is incommensurable to its* square roote, *prefix this Character before it,* viz. ∫ *or* ∫q. So the *square roote* of $7\frac{2}{3}$ will be thus expressed ; ∫ $7\frac{2}{3}$ or ∫q. $7\frac{2}{3}$: But if you desire to finde the *square roote* neare, of a mixt number *incommensurable* to its *roote*, reduce the fractionall part of the mixt number into a *Decimall* of an even number of places, as in the 22. *rule* of this chapter, and annex the *Decimall* so found unto the whole part of the mixt number ; Then esteeming the said whole number and *Decimall* as one intire number, extract the *square roote* thereof according to the afore going *rules* of this chapter, and from the root found, cut off alwayes to the right hand, so many places as there are points over the Decimall annexed, which number so cut off shall be a *Decimall*, shewing the fractionall part of the root, and that on the left hand shall bee the whole part of the

roote; So the *square roote* of $7\frac{2}{3}$ will be found 2.7688 *ferè.*

Chap. XVIII.

The Extraction of the Cube roote.

I. THe *Extraction of the cube roote is that, by which having a number given, we finde another number, which being first multiplied by it selfe, and then by the Product produceth the number given.*

A Cube Number.

II. *In the extraction of the cube roote the number propounded is alwayes conceived to be a cube number, that is, a certain number of little cubes comprehended within one intire great cube, and the roote or number required is the side of the square, which constitutes that great cube.* What a *cube* is may bee well exprest by a *die,* which indeed is a little *cube* it selfe; wherefore if you place foure *dice* in a square form, that is, laying two and two in a ranke you shall have a square containing foure *dice,* upon which if you yet erect such another square of *dice,* you shall have

have a great intire *cube* comprehending two times foure, that is, 8 *dice* or little *cubes*; And here 8 is the *cube number* given, and 2 is the *roote,* or number required: In like manner if you ranke 25 *dice* in a square form, *viz.* laying 5 in a ranke, you have a square containing 25 *dice,* now upon this square of *dice* if you erect foure other like squares, you shall have a great intire *cube* comprehending 5 times 25, that is, 125 little *cubes*; and in this case 125 is the *cube number* propounded, and 5 the *roote,* or number required.

III. *A cube number is either single or compound.*

A single Cube Number.

IV. *A single cube number is that which being produced by the multiplication of one single figure first by it selfe, and then by the Product, is alwayes lesse then* 1000. So 125 is a *single* cube number produced by 5 multiplied *first* by it selfe, and *then* by 25 the Product; for 5 times 5 is 25; and 5 times 25 is 125.

V. *All the single cube numbers, and square numbers, together with their respective rootes, are expressed in the Table following.*

1	8	27	64	125	216	343	512	729
1	4	9	16	25	36	49	64	81
1	2	3	4	5	6	7	8	9

Here in the uppermost ranke of the *Table* are placed the *single cube numbers* of the particular figures 1,2,3,4,5,6,7,8,9; in the next the *squares* of those figures, and in the lowest ranke the *figures* themselves, being the respective *rootes* of the cubes and squares in the uppermost rankes; and therefore the *cube roote* of 125 being demanded, the *answer* is 5, and the *cube roote* of 216 being required, the Table will give you 6, and so of the rest.

VI. *When a cube number is given, that exceeds not* 1000, *and yet is none of the Cube numbers mentioned in the Table; for his roote you are to take the roote of the cube number, that being lesse comes nearest unto it.* So 157 being given, the *roote* that belongs unto it is 5.

A compound Cube Number.

VII. *A compound cube number is that, which being produced by a number, that consists of moe places then one, first multiplied by it selfe, and then by the Product, is never lesse then* 1000. So 157464 is a *compound cube number*, being produced by 54, multiplied *first* by it selfe, and *then* by 2916 the product, for 54 times 54 is 2916, and then 54 times 2916 is 157464, the *compound cube number* propounded.

VIII. *To prepare a cube number for extraction subscribe a point under every third figure from the last, placing one also under it*: So 157464 being given, you are to subscribe the points as in the margent, and so many points as are in that manner subscribed, of so many Figures the *roote* demanded will consist.

$1\dot{5}74\dot{6}4$

The Extraction.

IX. *Having thus prepared your number, you may see it distributed by the points into severall Cubes*: So in the same *example* 157 is the *first* cube, and 464 the *second*.

The first Operation.

X. *Having drawne a Quotient in the Margent finde the roote of the first cube, and place it in the quotient*: So I finding (by the *sixth* Rule of this Chapter) 5 to bee the correspondent *roote* of 157, I write 5 in the Quotient, and then the worke will stand *thus*:

$1\dot{5}74\dot{6}4(5$

XI. *Subscribe the cube of the roote under the first cube of the number given*: So

So 125 being the *cube* of 5 the roote (by the 5 Rule of this Chapter) I write it under 157 the *firſt cube* of the number given thus:

157464 (5
125

XII. *Subtract the cube of the roote out of the firſt cube of the number given, and having placed the Remainder above the firſt cube, cancell the Figures of the ſame, out of which the Subtracti-on is made,* this done, the worke will ſtand thus:

32
~~15~~7464 (5
125

The ſecond Operation.

XIII. *Draw a line under the worke, and having trebled the* roote, *ſubſcribe it under the ſecond Figure of the next cube,* as followeth in the *example,* for three times 5 being 15 I write it under 6 the *ſecond* Figure of the next *cube.*

32
~~15~~7464 (5
125
15

XIV. *Multiply the triple number by the roote, and place the Product under the firſt Figure of the ſecond cube, which product is more particularly called the Diviſor:* So 15 the *triple* number multiplied by 5, the Product is 75, which I place under 4 the *firſt* Figure of 464 the *laſt* cube of the number given, and this 75 is termed the *Diviſor*; *obſerve* the worke in the *Margent.*

32
~~15~~7464 (5
125
15
75

XV. *Demand how often the firſt Figure of the Diviſor is contained in the remaining Figures of the cube number placed above it, and obſerving in that behalfe the rules before taught in Diviſion, write the Anſwer in the quotient:* So if I aske how often 7 the firſt Figure of the *Diviſor* is in 32 the remaining figures of the cube number placed above it, the *anſwer* will be 4, wherefore I write 4 in the Quotient, and then the worke ſtands, as you ſee it in the *Margent.*

See the Rules of the 5. Chapter.

32
~~15~~7464 (54
125
15
75

XVI. *Draw again another line under the worke, and ſubſcribe the cube of the Figure laſt placed in the quotient under the*

the last Figure of the second cube of the number given: So 64 being the *cube* of 4, I write it under 4 the *last* figure of the *last* cube of the number given, and then the worke stands thus:

```
  32
 157464 (54
125
  15
  75
   64
```

XVII. *Multiply the Figure last placed in the quotient first by it selfe, and then the product by the triple number; this done, subscribe the last Product under the triple number.*

So 4 being multiplied by it selfe the product is 16, which being againe multiplied by 15 the *triple* number, the product is 240, this therefore I place under the *triple* number, thus:

```
  32
 157464 (54
125
  15
  75
   64
  240
```


XVIII. *Multiply the divisor by the figure last placed in the quotient, & write the product under the divisor*: So 75 being multiplied by 4 the product is 300, which I write under 75 the *divisor*, as you may observe in the *example*.

```
  32
 157464 (54
125
  15
  75
   64
  240
 300
```

XIX. *Drawing yet another line under the work adde the 3 last numbers together, and the summe thereof deduct out of the remaining Figures of the number given, proceeding in that behalfe, as you are directed in the* XII. *Rule aforegoing*: So the *sum* of the 3 last numbers as they are ranked in the work is 32464, which if you subtract out of 32464 the remaining figures of the number given, the remainder is 0; And then the whole worke being finished, the *cube root* of 157464 the number propounded is found to be 54, and thus if the number should consist of never so many *cubes*,

```
 32000
 157464 (54
125
  15
  75
   64
  240
 300
 32464
```

See the 7. Rule of the 5. Chapter: and the 16 Rule of the last Chapter.

they are all resolved as the last cube of the number given; But here observe by the way, that when the summe of the three last numbers is greater then the remaining Figures above it, the worke is erroneous, and then you are to reforme it by placing a lesse Figure in the quotient, as you were taught before in *Division*, and in the extraction of the *square roote*.

XX. *When after the whole worke is finished any Figures remain of the last subtraction, they are the numerator of a fraction, which hath the triple roote, and the square of the roote trebled with an Unite added together for his denominator, and is to be annexed unto the number in the quotient as the broken part of the number required:* So if the *cube roote of* 8302348 bee demanded, you shall finde it 202 $\frac{59542}{123019}$, as you may observe by the operation hereunto annexed. For having distinguished the Number propounded into severall cubes by points; First I demand the cube roote of 8 the first cube, which I finde by the 5 rule of this Chapter, to bee 2, wherefore placing 2 in the quotient, and 8 the cube thereof under 8 the first cube, I subtract 8 out of 8, and finding nothing to remaine, I cancell 8 the

The first Operation.

the first Cube, placing 0 above it.

0059940
8302348 (202 $\frac{59940}{123019}$
8
6
12
60
1200
8
240
2400
242408

Then drawing a Line under the worke, and *trebling* 2, I place 6 the *treble* thereof under 0 the *second* Figure of the next *Cube*. Againe, multiplying 6 the *treble* Roote by 2 the roote, I place 12 the Product thereof (otherwise termed the *Divisor*) under 3 the *first Figure* of the same Cube; after this I demand how often 1 the first Figure of the *Divisor* is contained in 0 the Figure or note above it, and not finding it once contained in it, I write 0 in the Quotient (according to the 11th. Rule

The second Operation.

they are all resolved as the last cube of the number given; But here observe by the way, that when the summe of the three last numbers is greater then the remaining Figures above it, the worke is erroneous, and then you are to reforme it by placing a lesse Figure in the quotient, as you were taught before in *Division*, and in the extraction of the *square roote.*

XX. *When after the whole worke is finished any Figures remain of the last subtraction, they are the numerator of a fraction, which hath the triple roote, and the square of the roote trebled with an Unite added together for his denominator, and is to be annexed unto the number in the quotient as the broken part of the number required :* So if the *cube roote of* 8302348 bee demanded, you shall finde it 202 $\frac{59942}{123019}$, as you may observe by the operation hereunto annexed. For having distinguished the Number propounded into severall cubes by points; First I demand the cube roote of 8 the first cube, which I finde by the 5 rule of this Chapter, to bee 2, wherefore placing 2 in the quotient, and 8 the cube thereof under 8 the first cube, I subtract 8 out of 8, and finding nothing to remaine, I cancell 8 the

The first Operation.

the first Cube, placing 0 above it.

```
 0059940
 8302348 (202 59940/123019
 8
 ------------
   6
  12
 ------------
     60
  1200
 ----------------
       8
    240
  2400
 ----------------
 242408
```

Then drawing a Line under the worke, and *trebling* 2, I place 6 the *treble* thereof under 0 the *second* Figure of the next *Cube.* Againe, multiplying 6 the *treble* Roote by 2 the roote, I place 12 the Product thereof (otherwise termed the *Divisor*) under 3 the *first Figure* of the same Cube; after this I demand how often 1 the first Figure of the *Divisor* is contained in 0 the Figure or note above it, and not finding it once contained in it, I write 0 in the Quotient (according to the 11th. Rule

The second Operation.

Rule of the fifth Chapter.) And now, because the *summe* of the three Numbers, which ought to have beene produced by the multiplication of 0, the *last Figure* placed in the Quotient amount to 0, these Figures 302, out of which that *summe* should have beene subtracted remaine the same without *Alteration*: wherefore drawing another Line under the worke, and *trebling* 20 the Roote, I place 60 the *treble* thereof under 4 the second Figure of the last Cube: Likewise multiplying 60 the *treble* Number, by 20 the Roote, I place 1200, the Product (being also the next *Divisor*) under 3 the *first Figure* of the same Cube. Then I demand *as before* how often 1 the first Figure of the *Divisor* is in 3 the Figure above it, and though it bee three times contained in it, yet dare I take but 2 (according to the seaventh Rule of the fifth Chapter) which I write likewise in the Quotient.

The third Operation.

Again, drawing a third Line under the worke, I take 8, which is the *Cube* of 2 the last Figure placed in the Quotient, and place it in the ranke of 8 the last Figure of the last Cube. In like manner multiplying the same 2, *First* by it selfe, and

and then 4 the Product thereof by 60 the *triple* Number, I write 240 the last Product under 60 the *triple* Number.

Last of all, multiplying 1200 the last *divisor* by the same 2, I write 2400 the Product under 1200 the *Divisor*; all this performed, the *summe* of these three Numbers, *viz.* 8, 240, and 2400 as they stand in the worke is 242408, which being *subtracted* out of 302348 the Figures above, there *remains* 59940 of the last *Subtraction*. The worke being thus farre prosecuted 202 are found to bee the whole part of the Roote required, and as for the *Fraction* annexed, 59940 the Figures remaining are the *numerator* thereof, and 123019 the denominator; for 202 the root being trebled is 606, and the *Square* thereof is 40804 (for 202 times 202 is 40804) which *Square* being trebled is 122412: I say therefore these three, *viz.* 606 the triple Roote, 122412 the Square of the Roote trebled, and 1 being added together, the *summe* is 123019 the *Denominator* of the *Fraction* annexed, *as aforesaid.*

XXI. *The Extraction of the Cube Roote is proved by multiplying the Roote by* The proofe.

by his Square: For the Product will bee equall to the Number given: So in the first *example* 54 the Roote multiplyed by 54 produceth 2916 his *Square*, which being againe multiplyed by 54, the Product is 157464 the *Number given:* But when the Quotient hath a *Fraction* annexed, adde the *Numerator* of the fraction to the last Product, and so the *Summe* will likewise equall the *Number given*, as in the last example 202 being multiplied by 202, the Product is 8242408, unto which if you adde 59940 the *Numerator* of the *Fraction* annexed, the *summe* is 8302348 the *Number propounded.*

Ram. Geom. L. 24. Elem. 6 XXII. *The broken part of the* Cube Roote *may likewise bee found out by annexing a competent Number of Ternaries of Cyphers*, videlicet, *either* 000, 000000, *or* 000000000, *&c. Cyphers unto the Number given; and in this Case the broken part annexed is alwayes a decimall;* as in the Extraction of the Square Roote: So likewise here, the *broken part* of the Cube Root may be the more exactly discovered by annexing *Cyphers* unto the Number given: So 8302348 being propounded *as before*,

to

to find the Cube Root thereof (according to this Rule) annexe *Cyphers* unto it in this manner, 8302348000000000, &c. And then proceede as you are directed by the *Patterne* following, in which although you see but part of the worke performed, yet by it you may easily understand how to finish the rest.

1042

1042

10878507

005994017600

83023480000000, &c. (202.48, &c.

8

Oper. II.

6

12

Oper. III.

60

1200

8

240

2400

242408

Oper. IV.

606

122412

64

9696

489648

49061824

Oper. V, &c.

6072

12289728

512

388608

98317824

9835668992

XXIII. *The* Cube roote *of a Fraction is found in this manner,* viz. *Extract the* Cube roote *of the Numerator (according to the aforegoing Rules) which* roote *shall be a new Numerator; Also the* Cube root *of the* Denominator *is a new* Denominator, *so is the new Fraction the* Cube roote *of the Fraction given.* To extract the Cube roote of a Fraction.

Thus the *Cube roote* of $\frac{8}{27}$ is $\frac{2}{3}$, *viz.* the *Cube roote* of 8 is 2 for a new Numerator: Also the *Cube roote* of 27 is 3 for a new Denominator.

XXIV. *When either the Numerator or Denominator hath not a perfect Cube root,* viz. *when such Fraction is incommensurable to its Cube roote, the Cube roote of such Fraction is expressed by prefixing this Character* √c. *before the Fraction given.* Of Fractions incommensurable to their Cube roots.

So the *Cube roote* of $\frac{2}{3}$ is thus expressed √c. $\frac{2}{3}$. But here you are to observe that if the *Fraction* whose *Cube roote* is required, be not in its *least Tearmes*, it is first of all to bee reduced into its *least Termes* by the 3. rule of the 7. Chapter: for although the former be *incommensurable* to its *roote*, yet the latter may be *commensurable*; so in this *Fraction* $\frac{16}{54}$ each Terme is *incommensurable* to its *Cube roote*, but the

said $\frac{16}{54}$ being reduced to its *least Termes* $\frac{8}{27}$, there will bee found in each Terme a commensurable *Cube roote*, as is manifest by the last *Rule*.

To find the Cube roote neare of a Fraction incommensurable to its Cube roote.

XXV. *The cube roote of a Fraction which is incommensurable to its roote, may be found neare, in this manner*, viz. *reduce the Fraction proposed into a Decimall by the 2. rule of the 12. chapter, the more places are in the decimall, the nearer will the roote be found, but the decimall must consist of ternaries of places*, viz. *either of three, sixe, nine, or twelve &c. places; Then extract the cube roote of that decimall as if it were a whole Number, according to the aforegoing Rules, which roote found shall be a decimall expressing neare, the cube roote of the Fraction proposed:*

So if the cube roote of $\frac{2}{3}$ bee required neare, reduce the said $\frac{2}{3}$ into a decimall (by the 2 Rule of the 12. chapter) which will be found, *666666666666*, &c. then extracting the cube roote thereof as if it were a whole number it will bee found *.8735 ferè*.

To extract the Cube roote of a mixt number.

XXVI. *The cube roote of a mixt number commensurable to its roote is found in the same manner as in the 23. Rule of this chapter, the mixt number being first reduced into an improper Fraction by the 9. rule of the 7. chapter.*

So the cube roote of $12\frac{19}{27}$ will be found $2\frac{1}{3}$, *viz.* reducing $12\frac{19}{27}$ into an improper Fraction it will bee $\frac{343}{27}$, whose cube roote will be found $\frac{7}{3}$ (by the 23. rule of this chapter,) which being reduced according to the 12. rule of the 7. chapter, is $2\frac{1}{3}$ the cube roote sought. And here the same caution is to be observed as in the 24 rule of this chapter, *viz.* the Fractionall part of the mixt number, or the improper fraction equivalent unto the mixt number, must be in the *least Termes* before any extraction be made.

To finde the Cube roote neare of a mixt number incommensurable to its Cube roote.

XXVII. *When the mixt number whose cube roote is required, is incommensurable to its cube roote, prefixe this character before it*, viz. *ℒc. so the cube roote of $2\frac{3}{8}$ will be thus expressed ℒc.* $2\frac{3}{8}$; But if you desire to finde the cube roote neare, of a mixt number *incommensurable* to its root, reduce the fractionall part of the mixt number into a *decimall* as in the 25. rule of this chapter, and annexe the *decimall* so found, unto the whole part of the mixt number; Then esteeming the said whole number and *decimall* as one intire number, extract the cube roote thereof according

to the aforegoing rules of this chapter, and from the roote found, cut off alwayes to the right hand so many places as there are points over the said *decimall* annexed, which number so cut off shall be a *decimal* shewing the fractionall part of the roote, and that on the left hand shall be the whole part of the roote; so the cube roote of 2 $\frac{3}{8}$ will be found 1. 334 *ferè*.

XXVIII. I might here proceed to shew the extraction of other *roots*, as the *Biquadrate*, *Quadrato cube*, *Cubo cube* &c. but in regard they serve more for curiosity then use, being exceeding tedious in operation, and cannot naturally be understood without the knowledge of *Algebra* in *Species*, I shall onely touch upon the extraction of the *Biquadrate* or *Quadrato quadrate roote*, because it may bee extracted by the rules formerly mentioned in the Extraction of the *Quadrate* or *Square roote* in chapter 17.

To extract the Biquadrate root.

XXIX. *The extraction of the Biquadrate roote is that, by which having a number given, we finde another number which being first multiplyed into it selfe, and then that Product multiplied into it selfe, produceth the number given*; So the Biquadrate roote of 16, is 2, which being multiplied into it selfe produceth 4, which being multiplied into it selfe produceth 16.

XXX. The Biquadrate roote of any Number commensurable to its roote may be found in this manner, viz. *Extract the Square roote of the Number given, according to the Rules of the 17. chapter, then extract the Square roote of that roote first found, so will the latter roote bee the Biquadrate roote sought.*

Thus if 20736 bee given, the *Biquadrate roote* thereof will bee found 12, *viz.* the square roote of 20736 will bee found 144, and the square roote of 144 will be found 12, which is the Biquadrate roote sought; When the Number given is incommensurable to its Biquadrate roote, annexe Quaternaries of Cyphers, *viz.* either 0000, 00000000, &c. and then proceede as before; so will you finde the roote neare, whose Fractionall part will be a Decimall.

Chap. XIX.

The Relation of Numbers in Quantitie.

I. *THus farre single Arithmetique, comparative Arithmetique issues, which is wrought by Numbers, as they are considered to have Relation one to another.*

Boetius Arith. l. 1. cap. 21.

II. *This Relation consists in quantity, or quality.*

III. *Relation in quantity is the Reference or Respect, that the numbers themselves have one unto another:* As when the comparison is made betwixt 6 and 2, or 2 and 6: 5 and 3, or 3 and 5.

IV. *Here the Termes or Numbers propounded are alwayes two, whereof the first is called the Antecedent, and the other the Consequent:* So in the first example, 6 is the *Antecedent*, and 2 the *consequent*: and in the second, 2 is the *Antecedent*, and 6 the *consequent.*

V. *Relation in Quantity consists in the difference, or in the rate and reason that is found betwixt the Termes propounded.*

VI. *The difference of two Numbers is the Remainder, which is left after subtraction of the lesse out of the greater:* So 6 and 2 being the Termes propounded, 4 is the difference betwixt them: for if you subtract 2 out of 6 the remainder is 4. Difference.

VII. *The rate or reason betwixt two numbers is the quotient of the Antecedent divided by the Consequent:* So if it bee demanded what rate or reason 6 hath to 2, I answer, Triple reason: for if you divide 6 the Antecedent, by 2 the Consequent, the quotient is 3, 2 being contained just 3 times in 6. In like manner is there triple reason betwixt 2 and 6, for if you divide 2 by 6, the quotient is $\frac{2}{6}$ or (which is all one) $\frac{1}{3}$ because 6 being not once found in 2, there remains 2 for the Numerator, 6 the Divisor being the Denominator of of the fraction given you in the Quotient, according to the 17. Rule of the 5. chapter aforegoing. Rate or Reason.

VIII. *This rate or reason of numbers is either equall or unequall.*

IX. *Equall reason is the Relation that equall numbers have unto one another:* As 5 to 5, 6 to 6, 7 to 7, &c. Equall Reason.

X. *Here the one being divided by the*

other, the quotient is alwayes an Vnite: for if it be demanded how often 5 is in 5, the answer is 1.

Unequall Reason.

XI. *Vnequall reason is the relation that unequall numbers have one unto another: and this is either of the greater to the lesse, or of the lesse to the greater.*

XII. *Vnequall reason of the greater to the lesse, is, when the greater Terme is Antecedent:* as of 6 to 2, 5 to 3, and the like.

XIII. *Here the quotient of the Antecedent divided by the Consequent is alwayes greater then an Vnite:* So 6 divided by 2, the Quotient is 3, and 5 divided by 3 the Quotient is $1\frac{2}{3}$.

XIV. *Vnequall reason of the lesse to the greater, is when the lesser Terme is Antecedent:* As of 2 to 6, 3 to 5, &c.

XV. *Here the quotient of the Antecedent divided by the consequent is alwayes lesse then an unite:* so 2 divided by 6, the Quotient is $\frac{2}{6}$ or $\frac{1}{3}$ and 3 divided by 5, the Quotient is $\frac{3}{5}$.

XVI. *Each of these kindes of unequall reason is againe subdivided into five other kindes or varieties, whereof the three first are simple, and the other two are mixt.*

XVII.

XVII. *The simple kindes of unequall reason are 1. Manifold. 2. Superparticular. 3. Superpartient.*

Manifold Reason.

XVIII. *Manifold Reason of the greater to the lesse is, when the Consequent is contained in the Antecedent divers times without any part remaining:* As 4 to 2, 8 to 4, 16 to 8, which is called Double reason, because the lesse is contained twice in the greater; So 6 to 2 is triple reason, 8 to 2 fourefold reason, &c.

XIX. *Here the quotient of the Antecedent divided by the Consequent is alwayes a whole number:* So 8 divided by 2, the Quotient is 4.

Submanifold.

XX. *The opposite of this kinde,* viz. *of the lesse to the greater, is called Submanifold:* Examples hereof are 2 to 4, 4 to 8, 8 to 16, &c. Likewise 2 to 6, 2 to 8, 2 to 10, &c.

Superparticular.

XXI. *Superparticular is, when the Antecedent containes the consequent once, and besides an aliquot part of the consequent;* that is, an halfe, a third, a fourth, or a fifth part, &c. of the *consequent,* as 3 to 2, 4 to 3, 5 to 4 6 to 5, and the like; here 3 divided by 2, the *quotient* is $1\frac{1}{2}$ and 4 being divided by 3, the *quotient* is $1\frac{1}{3}$. In like manner 5 divided by 4, the *quotient* is

is $1\frac{1}{4}$ and 6 divided by 5 the *quotient* is $\frac{1}{5}$, wherefore I say 2, and halfe 2 (that is 1) constitute 3: So likewise 3 and one third part of 3 (*viz.* 1.) constitute 4, and so of the rest.

XXII. *Here the quotient of the Antecedent divided by the Consequent is a mixt number, whose whole part, as also the numerator of the fraction annexed, is alwaies an unite*: as is observable in the examples last mentioned.

Subsuperparticular. XXIII. *The opposite reason of this kinde is Subsuperparticular*, as 2 to 3, 3 to 4, 4 to 5, 5 to 6, &c.

Superpartient. XXIV. *Superpartient is when the antecedent contains the consequent once, and besides divers parts of the consequent*: As 5 to 3, 7 to 6, 7 to 4, 8 to 5, 9 to 5, 11 to 7, &c. here 5 divided by 3, the *quotient* is $1\frac{2}{3}$ and therefore 5 containes 3 *once*, and $\frac{2}{3}$ of 3; for 3 and *two thirds* of 3 (*viz.*) 2, constitute 5.

XXV. *Here the quotient of the Antecedent divided by the consequent is a mixt number, whose whole part being an unite hath alwayes for the numerator of the fraction annexed unto it a number composed of moe unites then one*: So the conference being made betwixt 5 and 3, and 5 the Antecedent being divided by 3 the Consequent, the quotient is $1\frac{2}{3}$.

XXVI. *The opposite of this reason is Subsuperpartient*: Examples hereof are 3 to 5, 5 to 7, 4 to 7, 5 to 8, 5 to 9, 7 to 11, and the like. Subsuperpartient.

XXVII. *The mixt kindes of unequall reason are Manifold superparticular, and manifold superpartient.*

XXVIII. *Manifold superparticular reason is when the Antecedent contains the consequent divers times, and besides an aliquot part of the consequent*: As 5 to 2, 10 to 3, 17 to 4, 21 to 5, and the like. Manifold superparticular.

XXIX. *Here the quotient of the antecedent divided by the consequent is a mixt Number, whose whole part consisting of moe unites then one, hath alwayes an unite for the Numerator of the Fraction annexed unto it*; So 5 divided by 2; the Quotient is $2\frac{1}{2}$ and 21 divided by 5, the Quotient is $4\frac{1}{5}$.

XXX. *The opposite of this Reason is Submanifold Superparticular*; As 2 to 5, 2 to 7, 3 to 7, 4 to 9, &c. Submanifold superparticular.

XXXI. *Manifold Superpartient is, when the antecedent containes the consequent divers times, and besides divers* Manifold superpartient.

parts

parts of the consequent; As 8 to 3, 17 to 5, 19 to 4, 28 to 5, &c.

XXXII. *Here the Quotient of the Antecedent divided by the Consequent is a mixt Number, whose whole part as also the Numerator of the Fraction annexed unto it, is alwayes a Number composed of moe unites then one*: So 8 divided by 3, the Quotient is $2\frac{2}{3}$ and 28 divided by 5, the Quotient is $5\frac{3}{5}$.

Submanifold superpartient. XXXIII. *The Opposite here, is Submanifold Superpartient*: As 3 to 8, 5 to 17, 4 to 19, 5 to 28, and the like.

And these are the severall kindes or varieties of the Rates or Reasons that are found amongst Numbers, so that no two Numbers whatsoever can be named, but the Rate or Reason betwixt them is comprehended under one of these five kindes.

CHAP. XX.

The Relation of Numbers in Qualitie, where; of Arithmeticall and Geometricall Proportion.

I. R*Elation in quality (otherwise called Proportion) is the reference or respect that the Reasons of Numbers have one unto another.* *Vide Euclid. l. 3. d. 5. & Alsted. Arith. c. 5.*

II. *Therefore here the Termes propounded ought alwayes to be moe then two*, for otherwise there cannot be a comparison of Reasons in the Plurall number.

III. *This proportion is either Arithmeticall, or Geometricall.*

Arithmeticall Proportion. IV. *Arithmetical proportion is, when divers numbers differ according to equall reason*; that is, have equall differences, as 2, 4, 6, 8, 10, &c. here 2 is the common reason, or difference betwixt 2 and 4, 4 and 6, 6 and 8, 8 and 10, &c. So 1, 2, 3, 4, 5, 6, 7, &c. differ by *Arithmeticall* Proportion, 1 being the common reason or difference betwixt them.

V. *Arithmeticall Proportion is either continued, or interrupted.*

1. Continued. VI. *Arithmeticall Proportion continued is, when divers Numbers are linked together by a continued progression of equall reason:* Such are the examples last propounded, as also these 1, 3, 5, 7, 9, 11, 13, &c. And 100000, 200000, 300000, 400000, &c.

VII. *In a ranke of numbers that differ by Arithmeticall Proportion continued, the summe of the first and last Termes being multiplied by half the Number of the Termes, the Product is the totall summe of all the Termes:* So it being demanded, how many strokes the Clocke strikes betwixt midnight and noone; the Termes of the Progression in this question are twelve, *viz.* 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12. for in that order the Clocke strikes, wherefore if I multiply 13 the summe of 12 and 1 (the first and last Termes) by 6 (being halfe the number of the Termes) the Product is 78, which is the totall summe of all the Termes propounded being added together.

VIII. *Or thus, Multiply the number of the Termes by the halfe summe of the first and last Termes, and then likewise the Product will give you the totall of all the Termes:* so 13, 11, 9, 7, 5, 3. being given, their totall is 48, for 8 the halfe summe of 13 and 3, the first and last Termes being multiplied by 6, the number of the Termes, the Product is 48.

IX. *Three numbers being given, that differ by Arithmeticall proportion continued, the meane being doubled, is equall to the summe of the extreames:* So 5, 6, 7 being given, 6, being doubled is equall to the summe of 5 and 7 the two extreames.

X. *Arithmeticall Proportion may bee continued either upwards or downwards.*

XI. *Upwards, when the Termes of the Progression increase,* as these, 2, 4, 6, 8, 10, 12, &c. or these 1, 2, 3, 4, 5, 6, &c. And this last ranke is more particularly termed *Naturall Progression.* Upwards.

XII. *Here when the first Terme is also the common difference of the Termes, the last Terme being divided by the number of the Termes, the quotient will give you the first Terme of the ranke: again in this case the first Terme multiplied by the number of the Termes produceth the last Terme:* So this ranke 3, 6, 9, 12, 15, 18, 21, being propounded, wherein 3 is both the first Terme

Terme as also the common difference of the Termes: I say 21 the last Terme being divided by 7 the Number of the Termes, the Quotient is 3 the first Terme; Contrariwise 3 the first Terme multiplied by 7, produceth 21, the last Terme.

Downwards

XIII. *Arithmeticall Proportion continued downwards is, when the Termes of the progression decrease:* Such as are 35,32, 29,26,23,20: And 40,35,30, 25,20,15, 10,5.

This Rule is the inverse of the 12 Rule aforegoing.

XIV. *Here when the last Terme is also the common difference of the Termes, the first Terme being divided by the Number of the Termes, the quotient will give you the last Terme: Againe, the last Terme multiplied by the Number of the Termes, produceth the first Terme of the ranke.*

For example, this ranke 40,35, 30,25, 20,15,10, 5 being propounded, in which 5 is both the last Terme, and likewise the common difference of the Termes: I say, 40 the first Terme being divided by 8 the number of the Termes, the quotient is 5 the last Terme: on the other side 5 the last Terme being multiplied by 8, the Product is 40 the first Terme.

2. Interrupted.

XV. *Arithmeticall Proportion interrupted is when the progression is discontinued:* as in these numbers 2, 4. 8, 10; Here 2 and 4 being compared with 8 and 10 differ according to *Arithmeticall* proportion, but so doe not 4 and 8 differ, for 2 is the *common difference* betwixt 2 and 4, 8 and 10, whereas the *Difference* betwixt 4 and 8 is 4. In like manner 8, 14, 17,23, differ by *Arithmeticall* Proportion *interrupted.*

XVI. *Foure numbers being given, that differ by Arithmeticall Proportion either continued or interrupted, the summe of the two meanes is equall to the summe of the two extremes:* So 5,6,7, 8, being given, the summe of 6 and 7, the two *mean* numbers is equall to the summe of 5 and 8, the two extremes: And 8, 14 17, and 23, being propounded, the summe of 14 and 17 being added together is equall to the summe of 8 and 23.

Geometricall proportion.

XVII. *Geometricall Proportion is, when divers numbers differ according to like reason:* that is, when their *differences* are reasons of the same kinde; so 1,2,4,8, 16, 32,&c. which differ one from another by double reason, are said to differ by *Geometricall* Proportion, for as 1 is halfe 2, so 2 is halfe 4, 4 halfe 8, 8 halfe 16, 16 halfe 32,&c.

XVIII. *Geometricall Proportion is either continued or interrupted.*

1. Continued.

XIX. *Geometricall Proportion continued is, when divers numbers are linked together by a continued progression of the like reason* : Of this sort is the example last given: for as 1 is to 2, so is 2 to 4, 4 to 8, 8 to 16, 16 to 32, &c. So likewise the numbers 3, 9, 27, 81, 243, 729, &c. differ by *Geometricall* Proportion continued, *viz.* by triple reason, each of them being contained three times in the next number that followes it.

XX. *In Numbers continually proportionall from* 1, *the first number from* 1, *is the roote or first power, the second is the square or second power, the third the Cube or third power, the fourth the biquadrate or fourth power, the fifth the fifth power, the sixth the sixth power, &c.* So in this ranke of numbers, 1, 3, 9, 27, 81, 243, 729, &c. 3 is the roote, 9 the square, 27 the cube, 81 the biquadrat, 243 the fifth power, 729 the sixth power, &c.

Mean Proportionals.

XXI. *The roote being multiplied by it selfe produceth the square, which being again multiplied by the roote produceth the cube, and so each proportionall being multiplied by the roote produceth the proportionall next above it, and then the numbers comprehended betwixt* 1, *and the last number produced are called mean Proportionalls* : So in this ranke of proportionall numbers, 1, 2, 4, 8, 16, 32, &c. 2 the roote being multiplied by it selfe produceth 4 the square, which being againe multiplied by 2, produceth 8 the cube, then 8 being multiplied by 2, the Product is 16 the biquadrat, and so of the rest in their order, and here 2, 4, 8, and 16 are the meane proportionalls in the ranke propounded.

Continuall means. *Briggius Arith. Log. cap.* 6.

XXII. *If you multiply the roote by it selfe, and consequently the subsequent numbers by themselves, the numbers intercepted betwixt* 1 *and the number last produced may not unfitly bee called continuall means* : So 2 being given for the roote, and multiplied by it selfe, the product is 4, which being again multiplied by it selfe produceth 16, then 16 in like manner squared, produceth 256, which likewise multiplied by it selfe produceth 65536, I say then that 2, 4, 16, and 256 are continuall means betwixt 1, and 65536.

XXIII. *The continuall means comprehended betwixt any number given, and* 1, *are discovered by a continued extraction of the square rootes* ; for example 65536

being given, the roote thereof extracted is 256, whose roote is 16, then the roote of 16 is 4, and the roote of 4 is 2; so that at last I finde 256, 16, 4, and 2 to be continuall means intercepted betwixt 65536 and 1, as before.

XXIV. *In numbers that increase by Geometricall proportion continued, If you multiply the last Terme by the quotient of any one of the Termes divided by another Terme, which being lesse is next unto it, and then deducting the first Terme out of that Product, divide the remainder by a number that is an unite lesse then the quotient, the last quotient will give you the totall of all the Termes propounded in the progression*; So this ranke 2, 6, 18, 54, 162, 486, 1458, being propounded, wherein the proportionalls differ by subtriple proportion, I first take 2 and 6 the two first Termes, and dividing 6 by 2, I finde the quotient 3, wherefore multiplying 1458 the last Terme, by 3 the quotient, the Product is 4374, out of which I deduct 2 the first Terme, the remainder is 4372, which being divided by 2 (viz a number which is an unite lesse then 3 the quotient) the last quotient gives me 2186, which is the totall summe of the proportionalls propounded.

XXV. *Three proportionalls being given, the square of the meane is equall to the product of the extremes*: So 4, 8, and 16 being propounded, 8 times 8 being 64, is equall to 4 times 16, which is likewise 64.

XXVI. *Geometricall proportion interrupted is, when the progression of like reason is discontinued*; In such sort that foure numbers being given, the like reason is not found betwixt the second and third, that is betwixt the first and second, and the third, and fourth: Of this sort are these numbers 2, 4, 16, 32. here as 2 is to 4, so is 16 to 32, for they differ by double reason; but as 2 is to 4, so is not 4 to 16, for 4 and 16 differ by fourefold reason, 4 being contained foure times in 16: So likewise 4, 8, 8, 16, differ according to Geometricall proportion interrupted. 2. Interrupted.

XXVII. *The numbers of Multiplication and Division are proportionall*; For in Multiplication as 1 is to the Multiplicator, so is the Multiplicand to the Product, or as 1 is to the Multiplicand, so is the Multiplicator to the Product: Againe, in Division as the Divisor is to 1, so is the Dividend to the Quotient: or as the Divisor is to the Dividend, so is 1 to the Quotient.

XXVIII. *Foure proportionall Numbers whatsoever being given, the Product of the two means is equall to the Product of the two extremes:* So 2,4,16, 32. being propounded, 4 times 16 (which is 64) is equall to 2 times 32, which is likewise 64.

CHAP. XXI.

The Rule of Three direct.

I. F*Rom the last Rule of the Chapter aforegoing ariseth that precious Gemme in Arithmetique for the excellency thereof called the* Golden Rule.

II. The Golden Rule is that by which certain Numbers being given, another number Geometrically proportionall unto them may be found out.

III. The Golden Rule is either single or compound.

The Rule of Three.

IV. *The single Rule is, when three Termes or Numbers are propounded, and a fourth proportionall unto them is demanded: from whence it is likewise called* the Rule of Three.

V. *The*

The divers Denominations of the Termes thereof.

V. *The Termes of the Rule of Three consist of two Denominations,* viz. *two of the termes propounded have one, and the other terme given with the terme required have another:* So this question being demanded, If foure students spend nineteen pounds in certain moneths, how much will serve eight Students for the same time? the *Answer* will be 38 L. and here Students and Pounds are the two Denominations of the Terms in the question, whereof 4 and 8 (being two of the termes propounded) have the Denomination of Students. And 19 the other terme given together with 38 the terme required have the Denomination of Pounds.

The right ordering of the Termes.

VI. *In the rule of Three the numbers given must be so ranked, that the knowne number or terme upon which the question is moved, must possesse the third place in the rule, also that of the other two which is of the same Denomination with the third, must be in the first place, and consequently the other known terme which is of the same Denomination with the fourth terme required, (or answere of the question) must possesse the second place:* So in the question before mentioned, the termes 4, 19 and 8 are thus placed, *viz.* 8 is the terme upon

 which

which the queſtion is moved, and therefore to poſſeſſe the third place in the Rule, 4 is of the ſame Denomination with 8, *viz.* of Students, and therefore to be in the firſt place. Laſtly, 19 being of the ſame Denomination with the terme ſought, *viz.* of money, is to be in the ſecond place, and ſo they will bee placed in the rule *thus*:

ſtud.		*pounds*		*ſtud.*	
As 4 —	is to —	19 —	ſo is —	8 ..	to —

And here, for the better diſcerning of the terme upon which the queſtion is moved, you may obſerve, that for the moſt part it is the knowne number in the queſtion which immediately followeth theſe or ſuch like words, *viz.* How many? How much? What will? How long? How farre? *&c.*

Another example may be this, If certain buſhels of Provender ſerve 8 horſes 12 dayes, how many dayes will the ſame provender laſt 16 horſes? This queſtion being thus propounded, the termes thereof will ranke themſelves, as followeth.

horſ.	*da.*	*horſ.*
8 ——	12 ——	16

VII.

VII. *The Rule of Three is either direct, or inverſe.*

The Rule of Three direct.

VIII. *The Rule of Three direct is, when the terme required ought to proceed from the ſecond terme, according to the ſame rate and proportion that the third proceeds from the firſt*: So in the firſt example of the ſixth rule aforegoing, as 8 the third terme differs from 4 the firſt by double reaſon, ſo ought the terme required to differ from 19 the ſecond terme; that is, as 8 is double 4, ſo ought the terme required to be double 19; for if 19 pounds bee required to maintain foure Students three moneths, as much more muſt needs bee requiſite for the maintenance of 8 Students the ſame time; and therefore in this Caſe you may ſay in a direct proportion, as 4 is to 8, ſo is 19 to a number, which ought to be as great again as 19.

How to worke the ſame Rule. *viz.* 1. In whole Numbers, the Termes being ſingle Numbers.

IX. *In the direct Rule of Three if you multiply the ſecond terme by the third, or (which is all one) the third terme by the ſecond, and then divide the Product by the firſt, the quotient will give the fourth term, or fourth proportionall required*: So in the queſtion before propounded if you multiply 19 by 8, the Product is 152, which if you divide by 4, the Quotient will give you

you 38, the fourth Terme demanded, and then the whole work will ſtand thus:

```
4 ——— 19 ——— 8 ——— (38
       8
4)   152  (38
     12
     ——
      32
      32
     ——
       0
```

The ſecond example may be this, If 37 yards of Linnen cloth coſt 9 pounds, what is the price of a yard, at that rate? the anſwer will be $\frac{9}{37}$ l. or 4. ſh. 10. $\frac{14}{37}$ d. *viz.* 9 multiplyed by 1, is 9 for the Dividend, which being leſſe then the Diviſor 37, the Quotient will be found $\frac{9}{37}$ l. (by the 17th. rule of the 5th. Chapter.) Laſtly, $\frac{9}{37}$ l. will be reduced into 4. ſh. 10. $\frac{14}{37}$ d. by the 8th. rule of the 7th. Chapter.

yards, *l.* *yard.*
37 ——— 9 ——— 1 ——— ($\frac{9}{37}$ lb.

2. In whole Numbers, the Termes being compound.

The third example may be this queſtion, If a wedge of Gold waighing 19 Ounces, 3 penny waight and 5 Graines, bee worth 62 l.

62 l. 10. ſh. 6. d. What is the value of an Ounce of the ſame Gold? the anſwer will be found 3. l. 5. ſh. 3 $\frac{1629}{9197}$ d. And here obſerve that when either of the three known termes in the rule is *compounded* of numbers under *divers Denominations*, ſuch terme muſt bee reduced into the leaſt of thoſe Denominations (by the third rule of the ſixth Chapter.) Alſo when the firſt and third termes are not of the ſame particular Denomination; *viz.* If one of them be Ounces and the other Graines, or one of them Moneths, and the other Houres, &c. they are to bee reduced, into the leaſt of thoſe Denominations (by the ſecond rule of the ſixth Chapter;) So in this example, the three termes being reduced will ſtand in the rule thus:

graines *pence* *graines.*
If 9197 ——— 15006 ——— 480

Laſtly, proceeding according to the 9. rule of this Chapter, the *anſwer* will bee found 783 $\frac{1629}{9197}$ d. which being reduced according to the 8. rule of the 7. chapter, will be 3. l. 5. s. 3 $\frac{1629}{9197}$ d.

The fourth example may be this; If $\frac{5}{8}$ of a yard of Pluſh bee worth $\frac{2}{3}$ of a pound ſterling,

3. In Fractions.

ſterling, what is the value of $\frac{1}{16}$ of a yard of the ſame Pluſh? The *anſwer* will bee found $\frac{16}{240}$ li. or 1. s. 4. d. For if you proceed according to the ninth rule of this Chapter, with reſpect unto Multiplication and Diviſion in Fractions explained in the tenth and eleventh chapters, the *anſwer* will be found $\frac{16}{240}$ l. Or (which is the ſame in effect) *Multiply the Denominator of the firſt Terme, and the Numerators of the ſecond and third termes continually, ſo is the laſt Product a new Numerator: Alſo multiply the Numerator of the firſt terme, and the Denominators of the ſecond and third termes continually, ſo is the laſt Product a new Denominator, which new Fraction is the fourth terme ſought:* So in the ſaid example multiplying the Denominator 8, and the Numerators 2 and 1 continually, the Product will bee 16 for a new Numerator; Alſo multiplying the Numerator 5, with the Denominators 3 and 16 continually, the product is 240 for a new Denominator; ſo is the *anſwer* of the queſtion found to be $\frac{16}{240}$ l. which being reduced according to the 8. rule of the 7. chapter, will be 1. s. 4. d.

See continuall Multiplication in the laſt Rule of the 4. Chapter.

$$\overset{y.}{\tfrac{5}{8}} \text{———} \overset{l.}{\tfrac{2}{3}} \text{———} \overset{y.}{\tfrac{1}{16}} \text{—} \left(\tfrac{16}{240}\right. \text{lb.}$$

The

4. In mixt Numbers.

The fifth example may bee this, If a quantity of Amber greece waighing $1\frac{5}{7}$ lb. Troy be worth 60 pounds ſterling, what is the value of $19\frac{5}{8}$ graines? The *anſwer* will bee found 2. s. $4\frac{119}{192}$ d. Here you are to obſerve, that in the rule of three in *Fractions*, when either of the termes is a whole number or a mixt number, ſuch whole number or mixt number is to be reduced into an improper Fraction by the ninth or tenth rule of the ſeventh chapter: Alſo when the firſt and third termes are not of the ſame particular Denomination; ſuch of the ſaid termes which is of the leſſer Denomination, is to bee reduced into the greater Denomination by the 15. rule of the 7. chapter, and then the operation will be as before: ſo the termes of this *queſtion* being firſt of all reduced into improper Fractions, will ſtand in the rule thus:

$$\tfrac{12}{7}\ \text{lb.} \text{———} \tfrac{60}{1}\ \text{l.} \text{——} \tfrac{157}{8}\ \text{gr.}$$

And ſince the third terme $\frac{157}{8}$ gr. is not of the ſame Denomination with the firſt, it muſt be reduced into ſuch Denomination, *viz.* $\frac{157}{8}$ gr. is $\frac{157}{8}$ of $\frac{1}{24}$ of $\frac{1}{20}$ of $\frac{1}{12}$ of a pound Troy, which compound Fraction (by the fifteenth rule of the ſeaventh chapter,

ter,) will be reduced into the single Fraction $\frac{157}{46080}$ of a pound Troy, and so the termes will stand in the rule thus:

$$7\ \text{lb.} \text{———} \tfrac{62}{1}\ \text{l.} \text{———} \tfrac{157}{46080}\ \text{lb.}$$

Then working as in the fourth example, the *answer* will be found $\frac{65940}{552960}$ l. which being reduced by the eighth & third rules of the seventh chapter is 2. s. 4 $\frac{119}{192}$ d.

5. In Decimals. The rule of three in *Decimals* may bee exemplified by the *question* mentioned in the third *example* which is here repeated, *viz.* If 19 Ounces, 3 penny waight and 5 graines of Gold, be worth 62. l. 10. s. 6. d. what is the value of an Ounce ? The *answer* will bee found 3. l. 5. s. 3. d. *ferè.* viz. the termes being reduced into *Decimals* by the *Table of Reduction* in page 87 according to the 15. and 16. rules of the 12. chapter, will stand in the rule thus :

lb. *Troy*	l. *sterl.*	lb. *Troy.*
1.596701 ——	62.525 ——	.083333

Lastly, proceeding according to the 9. rule of this chapter, with respect unto Multiplication and Division in *Decimalls* explained in the fifteenth and sixteenth Chapters,

Chapters, the *answer* will bee found 3.263, &c. that is, 3. l. 5. s. 3. d. *ferè*, as will appeare by reducing the *Decimall* .263 according to the eighteenth or nineteenth rule of the twelfth Chapter.

X. *For the proofe of the direct rule of Three, multiply the fourth terme by the first, which done, if that Product be equall to the Product of the second and third Termes, the worke is right, otherwise it is erroneous* : So in the first *Example*, 38 being multiplyed by 4, the Product is 152, which is also the Product of 19 multiplyed by 8 as apppears by the *Example*. In like manner in the fourth *Example* $\frac{5}{8}$ (the first terme) being multiplyed by $\frac{16}{240}$ (the fourth terme) the Product will bee $\frac{80}{1920}$ which reduced according to the third Rule of the seventh Chapter is $\frac{1}{24}$, which is equall unto the Product of $\frac{2}{3}$ and $\frac{1}{16}$ the second and third termes, as appears by the worke. The proof.

CHAP.

Chap. XXII.

The Inverse Rule of Three.

I. *THe Rule of Three Inverse is, when the Terme required ought to proceed from the second terme according to the same rate or proportion, that the first proceeds from the third.* So in the last example of the 6 Rule of the 21. Chapter aforegoing, As 8 is halfe 16, so ought the terme required to be half 12, for if certain bushels of provender serve 8 horses 12 dayes, 16 horses will eat up as much provender in half that time; And therefore you cannot say here in a direct proportion (as before in the rule of *Three direct*) as 8 to 16, so is 12 to another Number, which ought to bee in that case as great again as 12. but contrariwise by an inverted proportion, beginning with the last terme first; as 16 is to 8, so is 12 to another number, which ought to be in this case half 12. And by the due observation of this definition together with that of the Rule of *Three direct* (propounded in the 8 Rule of the 21 Chapter) when any question discoverable by the *single Rule of Three* is propounded, you may readily discern by which of those rules it ought to bee resolved: for if the three termes given looke for a fourth in a *direct* proportion as they stand ranked in the rule, you must resolve the question by the *direct Rule*, contrariwise when the proportion is inverted or turned backwards, it ought to be resolved by the *Inverse rule of Three*.

II. *In the Inverse rule of Three if you multiply the first terme by the second, or (which is all one) the second by the first, and then divide the Product by the third, the quotient will yeeld you the fourth terme required:* So in the question premised in the last rule, if you multiply 12 by 8 the Product is 96, which if you divide by 16, the Quotient gives you 6, the fourth terme required. How to worke the Rule of Three Inverse.

8 —— 12 —— 16 —— 6

$$\begin{array}{r} 12 \\ 8 \\ \hline 16)\ 96\ (6 \\ 96 \\ \hline 0 \end{array}$$

By this last mentioned Rule it is evident, that

N

To discerne whether a question in the Rule of Three belong to the Rule direct, or Rule inverse.

that in the *rule* of three inverse, the third terme is the *Divisor*, and by the 9. rule of the 21. Chapter, it is also manifest that in the *rule* of three *direct* the first terme is the *Divisor*: Now for a further help to discover whether a question belong to the *rule direct* or *rule inverse*, observe alwaies by the tenour of the question whether more bee required or lesse; *viz.* Whether the terme sought must be greater then the middle terme or lesser, for when more is required, the lesser of the two extreme numbers is the *Divisor*, but when lesse is required, the greater extreme is the *Divisor*.

Lastly, the *Divisor* being knowne, it will bee apparent by what is before said whether it bee a *rule direct* or *rule inverse*.

Againe, take this for another *Example*; If 108 *Pioners* performe a piece of worke in 56 houres, in what time will 83 *Pioners* performe so much work?

108 —— 56 — 83 — $72\frac{22}{83}$

```
  108
   56
  ---
  648
  540
  ----
83) 6048 (72 22/83
  581
  ---
  238
  166
  ---
   72
```

So that 83 men are able to do as much worke in 72 houres, and $\frac{22}{83}$ of an houre, as 108 men can doe in 56 houres, which is the resolution of the *Question* propounded.

Another example; If $3\frac{1}{2}$ yards in length, of cloth which is $1\frac{3}{4}$ yards in breadth, will make a Cloake, how much stuffe which is $\frac{5}{8}$ of a yard in bredth, will serve as a lining for the said Cloake? *Facit* $9\frac{4}{5}$ yards. Worke according to the second rule of this Chapter, with respect unto Multiplication and Division in Fractions explained in the tenth and eleventh Chapters; Or which is the same (after the mixt numbers are reduced into Fractions)

Rule of Three inverse in Fractions.

Multiply the Denominator of the third terme and the Numerators of the first and second termes continually, so is the Product a new Numerator : Again, multiply the Numerator of the third terme, and the Denominators of the first and second termes continually, so is the Product a new Denominator, which new Fraction is the answer of the question.

breadth	*length*	*breadth.*
$1\frac{3}{4}$ *y.*	$3\ \frac{1}{2}$ *y.*	$\frac{5}{8}$
$\frac{7}{4}$	$\frac{7}{2}$	$\frac{5}{8}$

Facit $\frac{392}{40}$ *yards,* or $9\frac{4}{5}$ *yards.*

III. *In the Inverse rule of three, the Product of the third terme multiplied by the fourth, must accord with the Product of the first and second termes, otherwise the worke is erroneous* : So in the first example of the last rule the Product of 16 multiplyed by 6, is 96, which likewise is the product of 12 multiplied by 8.

If any bee desirous to exemplifie the rules in the subsequent Chapters by *Fractions* or *mixt Numbers*, he may do it by observing the 4 and 5. examples of the last chapter, and the last example of this chap.

CHAP.

CHAP. XXIII.

The double Golden Rule direct, performed by two single Rules.

I. *THe Compound Golden Rule is, when more then three termes are propounded.*

II. *Vnder the Compound Golden Rule is comprehended the double Golden Rule, and divers Rules of plurall proportion.*

The double Golden Rule.

III. *The double Golden Rule is, when five termes being propounded, a sixth proportionall unto them is demanded :* as in this question, If 4 Students spend 19 pounds in 3 moneths, how much will serve 8 Students 9 moneths? Or this, If 9 bushels of provender serve 8 horses 12 daies, how many dayes will 24 Bushels last 16 horses?

The parts into which the termes of the same rule are distributed.

IV. *The five termes given in this rule consist of two parts,* viz. *a supposition expressed in the three first termes ; and a demand, propounded in the two last :* So in the first example of the last rule, this clause (if 4 Students spend 19 pounds in 3

N 3 moneths)

moneths) is the ſuppoſition, and this (how much will ſerve 8 Students 9 moneths) is the demand: likewiſe in the other example of the ſame rule, this clauſe (if 9 buſhels of provender ſerve 8 horſes 12. dayes) is the ſuppoſition, and this (how long or how many dayes will 24 buſhels laſt 16 horſes) is the demand propounded.

The right ordering of the termes.

V. *Here for ranking the termes propounded in their due order, firſt obſerve amongſt the termes of ſuppoſition, which of them hath the ſame Denomination with the terme required, then reſerving that terme for the ſecond place write the other two termes of ſuppoſition one above another in the firſt place, and laſtly the terms of demand likewiſe one above another in the third place of the rule, in ſuch ſort that the uppermoſt may have the ſame Denomination with the uppermoſt of thoſe in the firſt place:* Example, If 4 Students ſpend 19 pounds in 3 monethes, how much will ſerve 8 Students 9 monethes? Here the three termes of ſuppoſition are 4, 19, and 3, and of theſe termes 19 hath the ſame *Denomination* with the terme required, *viz.* of pounds (for you are to inquire how much money is requiſite for the maintenance of 8 Students 9 monethes:) wherefore re-

ſerving

ſerving 19 for the ſecond place I write 4, and 3 one above another thus; then drawing a line upon the right hand of 4 I write 19 in the ſecond place; this done, the worke will ſtand as in the *Margent*: Laſt of all the termes of Demand being 8 & 9, and 8 having the *Denomination* of Students I place it in the ſame line with 4 and 19, and write 9 under it; all this performed the termes in this *queſtion* ranke themſelves as followeth:

4
3

4 — 19
3

viz. thus,

4 — 19 — 8
3   9

Or thus,

3 — 19 — 9
4   8

In like manner if the ſecond *queſtion* of the third Rule of this Chapter were propounded, the Termes thereof ought to be diſpoſed,

Thus,

8 — 12 — 16
9   24

Or thus,

9 — 12 — 24
8 16

VI. *Questions discoverable by the double Golden Rule may bee resolved by two single Rules of Three, or by the Golden Rule Compound of five Numbers.*

The proportions of the double Golden Rule when it is performed by two single Rules.

VII. *When questions of this nature are resolved by two single rules, the proportions are as followeth:*

I. *As the uppermost terme of the first place, is to the middle terme; So is the uppermost terme of the last place to a fourth Number.*

II. *As the lower terme of the first place is to that fourth Number; So is the lower terme of the last place to the terme required.*

So in this example before recited, using the lower terme of the first place as a common number in the first proportion, say *thus,*

4 — 19 — 8
3 9

I. If in three moneths 4 Students spend 19 pounds, what will serve 8 Students the same time?

Or thus, If foure Students spend nineteene pounds, what will eight spend?

Or thus, As 4 to 19, so 8 to another number.

And then the fourth proportionall answerable to 4, 19, and 8, the three Numbers given in this proportion, is 38 (by the ninth Rule of the one and twentieth Chapter aforegoing.) Again, to finde the terme required using the uppermost terme of the third place as a common Number in this last proportion, *say as followeth:*

II. If in 3 moneths 8 Students spend 38 pounds, how much will serve them for 9 moneths?

Or thus, If 3 give 38, what will 9 yeeld you?

Or thus, As 3 to 38, so 9 to the *terme required.*

Which you shall likewise finde (by the ninth Rule of the one and twentieth Chapter before cited) to bee 114. for 38 being multiplyed by 9 the Product is 342, which divided by 3 yeeld you in the quotient 114: So that *I conclude*, if foure Students spend nineteen pounds in three moneths, 114 pounds will serve 8 Students

dents 9 moneths; as you may further obſerve by the worke following:

4 — 19 — 8
3 9 — 114

4 — 19 — 8 — 38 3 — 38 — 9 — 114

```
     8                  9
4) 152 ( 38        3) 342 (114
   12                  3
   32                  04
   32                   3
    0                   12
                        12
                         0
```

VIII. *The double Golden Rule is either direct or inverſe.*

The double Golden Rule direct. IX. *The direct Rule is, when both the ſingle rules doe each of them looke for a fourth terme in a direct proportion:* As in the *example* of the 7. rule, for there the *first proportion* being this, if in 3 moneths 4 Students ſpend 19 pound, what will ſerve 8 Students the ſame time? here it is evident by the eighth rule of the one and twentieth chapter, that 4. 19, and

and 8, the three termes given, looke for a fourth in a *direct proportion:* And in the *last proportion* being this, if in 3 moneths 8 Students ſpend 38 pound, how much will ſerve them for 9 moneths? It is as manifeſt, that a fourth is likewiſe expected in a *direct proportion:* for if 8 Students in 3 moneths ſpend 38 pounds, they will ſpend in 9 moneths three times ſo much, and therefore here you may ſay in a *direct proportion*, as 3 the firſt terme is to 9 the third, ſo is 38 the ſecond to a fourth Number which ought to be in this caſe three times ſo great as 38, becauſe 9 is three times as great as 3, according to the eighth rule of the one and twentieth chapter before cited: Wherefore I *conclude* that this queſtion (if 4 Students in three moneths ſpend 19 pound, how much will ſerve 8 Students 9 moneths?) ought to be performed by the *double Golden Rule direct*, as above in the 7 rule of this chapter.

For another *Example* take this, If the carriage of 7, C. waight 128 miles, coſts 48 ſhillings, for how much may I have 3, C. waight carried 32 miles after the ſame rate? The termes of this queſtion according to the 5 rule of this chapter rank themſelves in *this order.* 128

128 —— 48 —— 32
7 3

Now to discover whether this question ought to bee resolved by the *double Rule direct*, or no, taking the lower terme of the first place, I *say*.

I. If the carriage of 7, C. 128 miles, cost 48, s. what will the carriage of 7, C. 32 miles cost?

This done, I see plainly that the *fourth terme* here expected proceeds from the other three in a *direct proportion*, for that number must needs happen to bee by the same rate and *proportion* lesse then 48, that 32 is lesse then 128: wherefore finding that fourth number by the ninth rule of the one and twentieth Chapter to be 12, s. I proceed to the second proportion, and say:

II. If the carriage of 7, C. 32 miles costs 12, s. how much must I give to have 3, C. carried the same distance?

And here likewise finding a *fourth number* to bee looked for in a *direct* proportion, I discover that fourth by the said ninth rule of the one and twentieth Chapter

to be $5\frac{1}{7}$ s. which is the *terme demanded*, and the answer to the question propounded: So that at last *I conclude*, If the carriage of 7, C. 128, miles cost, 48, s. the carriage of 3, C. 32, miles will cost mee $5\frac{1}{7}$ s. according to the same rate: See the whole work.

128 —— 48 —— 32
7 3 —— $5\frac{1}{7}$

128 —— 48 —— 32 —— 12

```
       48
       32
       96
      144
128) 1536(12
     128
     256
     256
       0
```

7 —— 12 —— 3 —— $5\frac{1}{7}$

```
      12
       3
 7)   36(5
      35
       1
```

CHAP.

CHAP. XXIV.

The Double Golden Rule Inverse, performed by two single Rules.

The double Golden Rule Inverse.

THe Double Golden Rule Inverse is, when one of the single Rules lookes for a fourth Terme in an Inverted proportion: As in the last example propounded in the fifth rule of the last Chapter. For there if you ranke the termes of that question, *thus,*

8 —— 12 —— 16
9 24

You shall finde the termes of th first proportion to looke for a fourth number in an inverted proportion: For if 9 bushels of provender serve 8 Horses 12 dayes, 16 Horses will eat up so much provender in halfe that time; But if you order the Termes *thus,*

9 —— 12 —— 24
8 16

You shall perceive the termes of the last proportion to expect a fourth in an *inverted* proportion, which will bee likewise the terme demanded; for then *I say.*

I. If 9 bushels of provender last 8 Horses 12 dayes, how long or how many dayes will 24 Bushels serve the same number of Horses?

And here the termes propounded looke for a fourth in a *direct* proportion, which I finde by the single Rule of *Three direct* to be 32. That fourth number being so found, *I say* again,

II. If 24 Bushels of provender, serve 8 Horses 32 dayes, how long will 24 Bushels last 16 Horses?

And here the fourth terme expected proceeds from the other three in an *inverted* proportion; for if 24 Bushels of provender serve 8 Horses 32 dayes, 24 Bushels will last 16 Horses a lesse time: wherefore howsoever you ranke the termes of this question, the proportions thereof being severed into two single Rules, you shall finde one of them alwayes *inverted,* and therefore the fourth term thereof alwayes discoverable by the single rule of Three

Three *inverse* : whereupon I conclude, that the same question being given, it ought to be resolved by the double Rule *Inverse*, and not by the double Rule *direct*, as those propounded in the last Rule of the former Chapter.

Now the Resolution of this question being ranked after the first manner is, *as followeth* :

8 —— 12 —— 16
9 24 —— 16

8 —— 12 —— 16 —— 6
8
16) 96 (6
96
0

9 —— 6 —— 24
6
9) 144 (16
9
54
54
0

Again

Again the resolution of the same *question*, being ranked after the last manner *is this*,

9 —— 12 —— 24
8 16 —— 16

9 —— 12 —— 24 —— 32
12
48
24
9) 288 32
27
18
18
0

8 —— 32 —— 16 —— 16
8
16) 256 (16
16
96
96
0

So that at last *I say*, If 9 bushels of provender serve 8 horses 12 dayes, 24

O bushels

bushels will last 16 horses 16 dayes, which is the resolution of the *question* propounded.

The substance of that which hath been delivered in this and the preceding *Chapter*, concerning the *double Rule of Three*, may be expressed as in the following *Rule, viz.*

Let the first single Rule consist of any three of the 5 numbers given, which will stand in Rule according to sense and reason, then (according to the latter part of the 2. Rule of the 22 Chapter) observe whether it be a Rule Direct or Inverse, and multiply accordingly; that done, place the Dividend for a Numerator, and the Divisor for a Denominator, so is such fraction (whether proper or improper) the answer of the first single rule; lastly, the said fraction, (or answer of the first rule) together with the other two termes in the question, which were not mentioned in the first single rule, must make the second single rule, which 3 termes, reason, together with the directions in the 6 rule of the 21 Chapter will shew how to order, then observing whether it be a rule direct or inverse, work it accordingly as a rule of 3 in fractions, so will the answer thereof be the answer of the question propounded.

Example. If I pay 28 *shillings* for the carriage of 3 *hundred weight* for 50 *miles*, how much ought I to pay for the carriage of 17 *hundred weight* for 84 *miles*, at the same rate? *Facit.* 13 l. 6 s. 6 $\frac{18}{25}$ d.

	C.	Sh.	C.	
I. If	3 ——	28 ——	17	*Rule direct.*
			28	
			136	
			34	
		Facit	476	*Shillings.*
			3	

II. If $\frac{50}{1}$ *Miles* —— $\frac{476}{3}$ *sh.* —— $\frac{84}{1}$ *miles.*

Facit $\frac{39984}{150}$ *sh.* or 13 l. 6 s. 6$\frac{18}{25}$ d.

Another way of resolution of the former question, by changing the termes in the first *single rule* may be thus.

	Miles	C.	Miles	
I.	50 ——	3 ——	84	*Rule Inverse.*
	3			

Facit $\frac{150}{84}$ *hundred waight.*

II. $\frac{150}{184}$ C.—$\frac{28}{1}$ sh.—$\frac{17}{1}$ C. *Rule direct.*

Facit as before $\frac{29984}{150}$ Shillings.

Another way, by changing the termes of the first *single rule.*

$$\begin{array}{llcccl} & & C. & M. & C. & \\ I. & If & 3 — & 50 — & 17 & \textit{Rule Inverse.} \\ & & & 3 & & \end{array}$$

Facit $\frac{150}{17}$ *Miles.*

II. If $\frac{150}{17}$ m.—$\frac{28}{1}$ sh.—$\frac{84}{1}$ m. *Rule direct.*

Facit as before $\frac{29984}{150}$ *Shillings.*

Thus you see that the first *single rule* may be varied three manner of wayes, one of which will alwayes be obvious, so that working as before, you will finde the answer of any question resolvable by the *double rule* of *Three*, or *Golden rule compound* of 5 numbers, with as much expedition, and as little charge to the memory, as by any othe way.

CHAP.

CHAP. XXV.

The Golden rule compound of five Numbers.

I. THe Golden rule compound of five numbers is, when the termes being ranked, as before, in stead of the double termes we use their products, and then proceed to finde the terme required by one single rule of Three.

II. *Here when the question propounded ought to be performed by the double rule direct, multiplying the termes of the first place, the one by the other take their product for the first terme, the middle number for the second, and the product of the two last termes for the third terme; this done, having found by the rule of three direct, a fourth proportional unto those three, that fourth terme so found is the number you look for*: So this question being again propounded, if 4 students spend 19 l. in 3 moneths, how much will serve 8 students 9 moneths: and the termes thereof being ranked as before, viz. *thus*, The Golden Rule compound of five Numbers performed by one single Rule Direct.

$$\begin{array}{ccc} 4 — & 19 — & 8 \\ 3 & & 9 \end{array}$$

The

The product of 4 multiplied by 3 is 12, and the product of 8 multiplied by 9 is 72; wherefore *I say*, As 12 to 19, so 72 to the terme required, which I finde by the single rule of *Three direct* to be 114. So that if 4 students spend 19 l. in three moneths, 114 l. will be requisite for the maintenance of 8 students 9 moneths, as you have it before resolved in the example of the 7 rule of the 23 Chapter aforegoing. See the whole operation, *as followeth*,

```
4 —— 19 —— 8
3           9 —— 114
--          --
12          72
            19
            --
            648
            72
           ----
      12) 1368 (114
          12
          --
           16
           12
           --
            48
            48
            --
             0
```

In

In like manner this being the *question* as before (in the last rule of the 23 Chapter.) If the carriage of 7 C. 128 miles, costs 48 s. what will the carriage of 3 C 32 miles stand me in? The *Answer* thereunto will be $5\frac{1}{7}$ s. as appears by the *work*.

```
128 —— 48 —— 32
  7     96     3 —— 5 1/7
 ---    ---   --
 896   288    96
       432
       ----
  896) 4608 (5
       4480
       ----
       128 (1/7)
       896
```

III. *When the Question propounded ought to be resolved by the double rule Inverse, having multiplied the double termes a cross, that is, the uppermost term of the first place by the lower of the last, and the uppermost of the last place by the lower of the first, write each product under the lower terme by which it is produced, and then if the Inverse proportion be found in the uppermost line, using those products as single termes, proceed to finde the terme required by the single rule* of

The Golden Rule compound of five Numbers performed by one single Rule Direct or Inverse.

of Three direct: But in case you finde the Inverse proportion in the lower line, perform the work by the single rule of Three Inverse.

So in the *example* above mentioned, if 9 bushels of provender serve 8 horses 12 dayes, how long will 24 bushels last 16 horses? Here if you rank the terms *thus*, you shall finde the *Inverse* proportion in the *first* line, as is observed in the last Chapter.

8 — 12 — 16
9 24

And therefore having subscribed the products according to the direction given you in this Rule, I proceed to satisfie the demand of this question by the *single rule of Three direct*, as appears by the work following,

8—


```
8——12——16
9       24——16
—       ——
144     192
         12
        ———
        384
        192
        ————
  144) 2304 (16
        144
        ———
         864
         864
         ———
           0
```

But the termes of this *question* being ranked *thus*; the *Inverse* proportion is found in the *lower* line, as you may observe likewise by the last Chapter; whereupon in this case to resolve the *question* I proceed by the *single rule of Three Inverse*, as appears by the work hereunto annexed: Howsoever therefore you work the question, you shall finde the *terme required* to be 16; so that at last I conclude, *as before* in the last Chapter. If 9 bushels of provender

9 — 12 — 24
8 16

vender ſerve 8 horſes 12 dayes, 24 buſhels will laſt 16 horſes 16 dayes.

```
        9——12——24
        8          16——16
       192         144
        12
       384
       192
144) 2304 (16
       144
       864
       864
         0
```

CHAP.

CHAP. XXVI.

The rule of Fellowſhip.

1. T*He rules of Plural proportion are thoſe, by which we reſolve queſtions, that are diſcoverable by mo golden rules then one, and yet cannot be performed by the double golden rule mentioned before in the three laſt Chapters.* Of theſe *rules* there are divers kindes and varieties according to the nature of the *queſtion* propounded; for here the termes given are ſometimes four, ſometimes five, ſometimes mo, and the termes required ſometimes mo then one, &c. All which will more plainly appear when we ſhall deliver certain *examples* of theſe Rules in the inſuing part of this *Treatiſe*, whither we purpoſely refer you, becauſe there we ſhall have opportunity to reſolve *queſtions* of that kinde with much more facility by the help of the *Logarithmes*, then we are here able to do by the concluſions of *Natural* Rules of Plural proportion.

Arithmetique:

Arithmetique: This in the *Interim* shall serve you for a light of these things, that when we have hereafter occasion to mention *rules of plural proportion*, you may the better understand what is meant thereby.

II. *Two particular rules of plural proportion are these, the rule of Fellowship, and the rule of Alligation.*

The Rule of Fellowship.

III. *The rule of Fellowship is that, by which in accompts amongst divers men (their several stocks together with the whole gain or losse being propounded) the gain or losse of each particular man may be discovered*: As in this *example*, *A* and *B* were sharers in a parcell of merchandize, in the purchase of which *A* laid out 7 l. and *B* 11 l. and they having sold this commodity, finde that their clear gains amounts to 54 s now here the question to be resolved by this Rule is, what part of that 54 s. accrues to *A*, and what to *B*, according to the Rate of the several sums or *stockes* which they adventured? Again, *A*, *B*, and *C* fraight a ship from the *Canaries* for *England* with 108 Tuns of Wine, of which *A* had 48, *B* 36, and *C* 24; the *Mariners* meeting with a storm at Sea, were constrained for the safety

safety of their lives, to cast 45 Tunne thereof over boord: here the *question* to be resolved is, how many of the 45 Tunne each particular Merchant hath lost according to the rate of his *adventure*?

IV. *The Rule of Fellowship is either single or double.*

V. *The single rule is, when the stocks propounded are single numbers*: So the examples of the 3 rule aforegoing ought both to be performed by the *single rule of Fellowship*, because there 7 l. and 11 l. being the several *stockes* of the first example, and 48, 36, and 24 being the particular *stockes* of the last, are all single numbers. 1. Single.

VI. *In the single rule of Fellowship take the total of all the stockes for the first terme, the whole gaine or losse, for the second, and the particular stocks for the third termes; this done, repeating the rule of Three so often, as there are particular stockes in the question, the fourth termes produced upon those several operations are the respective gains or losses of those particular stockes propounded*: So in the first *example* above mentioned 7 l. and 11 l. are the *stockes* propounded, How to work this Rule.

whose

whose total is 18 l. which I take for the first terme; Againe 54 s. the common *gain*, is the second terme, and 7 l. the first particular *stocke*, is the third terme of the first *proportion*; whereupon I say, as 18 l. to 54 s. so 7 l. to another number, which by the direct rule of *Three* I finde to be 21 s. *viz*. the part of the *gaine* due to *A*, that expended the 7 l. *stocke*. Then for the second *proportion* I say, as 18 l. to 54 s. so 11 l. to another number, which I likewise finde by the rule of *Three* direct to be 33 s. *viz*. the part of the *gain* due to *B* for his 11 l. *stock*.

$$\left.\begin{matrix}7\\11\end{matrix}\right\} 18 — 54 —— \text{Therefore} \left\{\begin{matrix}7 — 21\\11 — 33\end{matrix}\right.$$

Again in the other premised example, the particular losse that happens to *A* is 20 Tunne, to *B* 15, and to *C* 10 Tunne,

$$\left.\begin{matrix}48\\36\\24\end{matrix}\right\} 108 — 45 —— \text{Therefore} \left\{\begin{matrix}48 — 20\\36 — 15\\24 — 10\end{matrix}\right.$$

2. Double. VII. *The double rule of Fellowship is, when the stocks propounded are double numbers, viz. when each stock hath relation to a particular time*: *Example*, *A*, *B* and *C*, hold a pasture in common, for which they pay 45 l. *per annum*. In this pasture *A* had 24 Oxen went 32 dayes, *B* had 12 there 48 dayes, and *C* fed 16 Oxen there 24 dayes; now the *question* to be resolved by this *Rule*, is, what part each of these Tenants ought to pay of the 45 l. rent? And here you may *observe*, that the stockes propounded are *double* numbers, *viz*. each stock of Oxen hath reference to a *particular* time, for the respective stock of *A* is 24 Oxen, and its *particular* time is 32 dayes; again the stock of *B* is 12 Oxen, and the *respective* time is 48 dayes; and lastly, the stock of *C* is 16 Oxen, and its *peculiar* time is 24 dayes, which as you see are *double* numbers.

How to work the same Rule: VIII. *In the double rule of Fellowship multiply each particular stock by its respective time, and take the totall of their products for the first terme, the whole gain or losse for the second, and the said particular products of the double numbers for the third terms: This done, repeating, as before, the Rule of Three,* so

so often as there are products of the double numbers; the fourth terms produced upon those several operations, are the numbers you look for: So in the *example* of the last rule, the product of 24 and 32, is 768, the product of 12 and 48, is 576, and the product of 16 and 24, is 384, the sum of these products is 1728, which is the *first term* in the question, then 45 l. the rent is the *second terme*, and 768 the *first product*, is the *third terme* of the first proportion. Wherefore *I say*, As 1728 to 45 l. so 768 to another number, which I finde by the direct rule of *Three* to be 20 l. *viz.* the part of the rent that *A* ought to pay: Then for the second proportion *I say*, As 1728 to 45 l. so 576 to 15 l. which is the part that *B* ought to *pay*: And lastly, As 1728 to 45 l. so 384 to 10 l. *viz.* the part that *C* must *pay*.

768 }				{ 768-20
576 }	1728 — 45	—Therefore		{ 576-15
384 }				{ 384-10

The Proof. IX. *The rule of Fellowship is proved by Addition of the termes required*, whose *sum* ought to be equal to the *second terme* in the question, otherwise the whole work is erroneous: So in the first *example* of the 6. Rule aforegoing 21, s. and 33, s. being added together are equall to 54, s. the *second terme* in that question: Likewise in the last *example* of the same Rule, as also in the *example* of the last Rule, the *summe* of 20, 15, and 10, the termes required is equall to 45, the *second terme* propounded.

CHAP. XXVII.

The Rule of Alligation.

I. THe *Rule of Alligation is that, by which we resolve questions, that concerne the mixing of divers simples together.*

II. *Alligation is either Mediall, or Alternate.*

Alligation Mediall. III. *Alligation Mediall is, when having the severall quantities and rates of divers simples propounded, wee discover the mean rate of a mixture compounded of those simples.* So 10 bushels of wheat at 4, s. or (which is all one) 48, d. the bushell; 40 bushels of rye at 3, s. or 36, d. the

the bushell; and 50 bushels of barley at 2, s. or 24, d. the bushell; being mixed with 20 bushels of oates at 12, d. the bushell, the Rule of *Alligation mediall* sheweth you the meane price of that mistling.

The operation and proportions of the same Rule.

IV. *In Alligation mediall first summe the given quantities, then finde the totall value of all the simples: this done, the proportion will be as followeth.*

As the summe of the quantities is to the totall value of the simples:
So is any part of the mixture propounded to the required mean rate, or price of that part.

Repeating again the premised example of the third rule, I demand how much one bushell of that mistling is worth? Now the summe of 10, 40, 50, 20, (the given quantities) is 120 bushells: and the value of the 10 bushels of wheat at 48, d. the bushell, amounts to 480, d. for 48 being multiplyed by 10, the product is 480: again the value of the 40 bushell of rye at 36, d. the bushell is 1440, d. The value of the 50 bushels of barley at 24, d. the bushell is 1200, d. And the value of 20 bushels of oates at 12, d. the bushell is 240, d. All these values being added together,

their totall is 3360, d. I say then by the rule of *Three direct*, If 120 bushels give 3360 d. what will 1 bushell yeeld? The *Rule* presently answers me 28, d. whereupon I conclude, that a bushell of that mistling may bee afforded for 28, d. that is, 2, s. 4, d. which is the resolution of the *question propounded.*

120 —— 3360 —— 1 —— 28

In like manner if it bee demanded what 8 bushels or a quarter of that mistling is worth? The *Answere* will bee 224, d. which being divided by 12, and by that meanes reduced into *shillings*, is 18, s. 8, d.

120 —— 3360 —— 8 — 12) 224(18

The proof.

V. *In Alligation Mediall, the triall of the work is by comparing the totall value of the severall simples with the value of the whole mixture*: For when those sums accord, the operation is perfect: So in the *example* of the last rule.

12
104
96
8

 The

The value of

	l.	s.	d.
10 bushels of wheat at 4 s. the bushell is	2	0	0
40 bushels of Rye at 3 s. the bushell is	6	0	0
50 bushels of barley at 2 s. the bushell is	5	0	0
And 20 bushels of oats at 12 d. the bushel is	1	0	0
All which amount to	14	0	0

which is likewise the value of 120 bushels at 28 d. or 2 s. 4 d. the bushell, for that also amounts to 14 l.

Alligation Alternate.

VI. *Alligation Alternate is, when having the severall Rates of divers Simples given, we discover such quantities of them, as are necessary to make a mixture, which may beare a certaine rate propounded.*

Example: A man being determined to mixe 10 bushels of wheat of 4 s. or 48 d. the bushell, with rye of 3 s. or 36 d. the bushell, with Barley of 2 s. or 24 d. the bushell, & with Oats of 1 s. or 12 d. the bushell, the rule of *Alligation Alternate* will discover unto you how much Rye, how much Barley, and how much Oates he ought to adde unto the 10 bushels of Wheat; in such sort that the mixture of them all together may beare a certain rate or price propounded.

The right ordering of the termes.

VII. *In questions of Alligation alternate, you must ranke the termes in such sort that the given rate of the mixture may represent the roote, and the severall rates of the Simples may stand as branches issuing from that root*: So the example of the last rule being propounded, I demand how much Rie, Barley and Oates ought to be added to the 10 bushels of Wheat, that the mixture of all together may beare the rate or price of 28 d. or 2 s. 4 d. the bushell: And therefore drawing a line of connexion, I place 28 d. the given rate of the mixture, upon the left hand thereof by it self representing the roote, and likewise write the other rates propounded, *viz.* 48 d. 36 d. 24 d. and 12 d. one above another upon the right hand of that line of Connexion, which rates are conceived to issue from 28 d. as branches from the root, the fabrick hereof appeares plainly in the margent?

$$28 \left\{ \begin{matrix} 48 \\ 36 \\ 24 \\ 12 \end{matrix} \right.$$

How to couple the termes.

VIII. *Having ranked the termes in their*

their due order, linke the branches together by certain Arkes, in such sort that one that is greater then the roote or rate of the mixture, may alwayes be coupled with another that is lesse then the same: So in the premised example 48 may be linked with 12, and 36 with 24, or otherwise 48 may be coupled with 24, and 36 with 12, and then the work will stand,

Thus, 28 { 48, 36, 24, 12 } *Or thus*, 28 { 48, 36, 24, 12 }.

How to order the differences.

IX. *Having alligated the branches and found the differences betwixt them and the root, write the difference of each branch just against his respective yoke-fellow.* So the branches of the example aforegoing being linked after the first manner, and the difference between 28, and 48, (by the sixth Rule of the eighth Chapter of this Book) being 20, I place 20 just against 12 the respective yoke-fellow of 48. Againe, 16 being the *difference* betwixt 28 and 12, I write it just against 48: In like manner 8 being the difference between 28 and 36 I place it right against 24. And lastly 4 the *difference* betwixt 28, and 24, I write just against 36: In the end the whole *Fabricke* of the worke (as the branches are thus linked) will stand as in the *example*.

28	48	|	16
	36	|	4
	24	|	8
	12	|	20

But the branches being linked after the other manner, the worke will bee *thus* disposed:

28	48	|	4
	36	|	16
	24	|	20
	12	|	8

For in this case 48 hath 24 for his *yoke-fellow*, and the respective *Camerado* of 36 is 12: and here the interchangeable placing of the *differences* (as in the premised examples) is that which is more particularly termed *Alternation*.

X. *When one branch is linked to divers other branches, and not to one alone, the differences ought to be as often transcribed, as it is so diversly linked.* So in the premised *example*, the branches being linked after the last manner, you may (if you please) conceive 12 to be coupled both with

with 48 and 36; likewise 24 may be conceived to be linked with the same 48, and 36: Again, 48 may be understood to be linked with 24, and 12, as also 36 with the same 24 and 12: wherefore the *difference* betwixt 28 and 12 being 16, I write it both just against 48 and 36: In like manner the *difference* between 28 and 24 being 4, I write it likewise over against the same numbers: Again 20 being the difference betwixt 28 and 48, I place it just against 24 and 12; and 8 being the *difference* between 28 and 36, I write it likewise over against the same numbers: All this performed, the whole *frame* of the worke will stand as in the *Margent*:

28	48	16. 4
	36	16. 4
	24	20. 8
	12	20. 8

2. Take this for another *example*: it is required to *mixe* 10 bushels of Wheat at 48 d. the bushell with Rie of 36 d. the bushell, with Barley of 24 d. the bushell, and with Oates of 12 d. the bushell, and the *question* now is, how much Rie, Barley and Oates ought to bee added to the 10 bushels of Wheat, that the intire *mixture* may

may bee afforded at 16 d. the bushell; Here the branches of this *question* (according to the 8th. Rule of this Chapter) ought to be linked *thus*,

16	48
	36
	24
	12

And as for the *Alternation* of the differences, it is evident (by the present Rule) that the *difference* between 16 and 12 being 4, ought to be thrice transcribed, *viz.* first just against 48, then against 36, and last of all against 24. Again 32 the *difference* betwixt 16 and 48, as also 20 the *difference* between 16 and 36, and lastly 8 the *difference* betwixt 16 and 24, ought all to be placed just against 12.

16	48	4.
	36	4.
	24	4.
	12	32. 20. 8.

3. I determining to mixe 10 bushels of Wheat at 48 d. the bushell with Rie of 36 d. the bushell, with Barley of 24 d. the bushell, and with Oates of 12 d. the bushell, desire to know how much of each I ought

I ought to take, that I might afford the whole mixture at 40 d. the bushell: here the whole worke being ordered according to the Rules aforegoing, it will stand as *followeth*:

40	48	4. 16. 28.
	36	8.
	24	8.
	12	8.

4. A man intending to mixe 10 bushels of Wheat at 48 d. the bushell, with Rie of 36 d. the bushell, with Barley of 24 d. the bushell, with Pease of 16 d. the bushell, and with Oates of 12 d. the bushell, desires to know how much Rie, Barley, Pease and Oates he ought to adde to the 10 bushels of Wheat, that the whole masse of Corne so mixed might bee afforded at 20 d. the bushell? This *question* being thus propounded, the Termes thereof (by the Rules aforegoing) may bee *Alligated*, and the differences of the Termes *Alternated*, as *followeth*,

20	48	4. 8.
	36	4. 8.
	24	4. 8.
	16	28. 16. 4.
	12	28. 16. 4.

5. Lastly, a Goldsmith hath some Gold of 24 carects, other of 21 carects and other some of 19 carects fine, which he would so mixe with *Alloy*, that 120 Ounces of the intire *mixture* might beare 17 carects fine; now the *question* is, how much of each sort, as also how much *Alloy* he must take to accomplish his desire? Before you can well understand this *question*, it will be necessary to explain what a *Carect fine*, and what *Alloy* is: The Mint-Masters and Goldsmiths to distinguish the differing *finenesse* of Gold esteem an intire Ounce to containe 24 *Carects*, and an Ounce of Gold that being tried in the fire loseth nothing of the waight is said to be 24 *Carects fine*, again the Ounce that being tried loseth one foure and twentieth part of the waight, is said to bee 23 *Carects fine*: In like manner that which loseth $\frac{2}{24}$ of the Ounce, is esteemed to bee 22 *Carects fine*, and so consequently of the

What a Carect fine, and what Alloy is.

the rest: And as for *Alloy* it is silver, copper, or some other baser metall, with which the Goldsmiths use to mixe their Gold, to the intent they may moderate, or abate the *finenesse* thereof. Here you may also observe that as the *finenesse* of *Gold* is measured by *Carects*, so is the *finenesse* of *Silver* estimated by *Ounces*: In such sort that a *pound* of *Silver*, which being *tried* a certain time in the fire loseth nothing of the *waight*, is said to bee 12 *Ounces fine*. But a *pound* that being tried loseth somewhat of the *waight* is said to bee the *remainder* of the *waight fine*. *Example*, a *pound* of *Silver* that loseth in the fire one *Ounc*. 8 p. is estimated to be 10 *Ounc*. 12 p. *fine*, and that which loseth 2 *Ounc*. 8 p. 10 *Grains*, is said to be 9 *Ounc*. 11 p. 14 *Grains fine*, &c. Now to ranke the termes of the last mentioned *question*, as also the differences of the termes in their due order, because the three given branches (*viz*. 24 *Carects*, 21 *Carects*, and 19 *Carects*) are all greater then 17 *Carects* the *root* or rate of the *mixture*. I adde 0, as another branch which I conceive to be lesse then the *root*, and then proceed as in the former operations; the whole *frame* of the worke is expressed here, as followeth:

17

17	24	17
	21	17
	19	17
	0	7. 4. 2.

XI. *When in one and the same line there are found more differences then one, adde them together, and write the summe just against the same differences before a straight line drawne towards the right hand of the work.* How to adde the differences.

So the first *example* of the last rule being propounded, the summe of 16, and 4, (the differences placed just against the first branch) being 20, I write it over against the same *differences* before the new line drawn upon the right hand of the work, and so consequently the rest in their due order, as appears by the *example* hereunto annexed:

28	48	16. 4.	20
	36	16. 4.	20
	24	20. 8.	28
	12	20. 8.	28

In like manner the last *example* of the last Rule being offered, the whole Fabricke

bricke

bricke of the worke will stand, as followeth:

17	24	17	17
	21	17	17
	19	17	17
	0	7. 4. 2.	13

XII. *Alligation Alternate is either Partiall or Totall.*

Alternation partiall.

XIII. *Alternation Partiall is, when having the severall rates of divers Simples, and, the quantitie of one of them given, we discover the severall quantities of the rest, in such sort that a mixture of those Simples being made according to the quantity given, and the quantities so found, that mixture may beare a certaine rate propounded:* Of this kinde is the *example* of the sixth rule, as also all the *examples* of the 10 rule except the last.

The proportions used in this rule.

XIV. *In questions of Alternation Partiall, the proportion is as followeth:*

As the difference annexed to the first branch is to the severall differences of the rest:

So is the quantity propounded to the severall quantities required.

So the *example* of the sixth and seventh rules

rules of this Chapter being again repeated, and the *Termes* thereof, as also the *differences* of the *Termes* being ordered after the first manner (shewed you in the ninth rule aforegoing) It is evident that for every 16 bushels of Wheat that I take in the *mixture*, I ought to take 4 bushels of Rie, 8 bushels of Barley, and 20 bushels of Oates; And therefore I say,

28	48	16	The first Case.
	36	4	
	24	8	
	12	20	

I. As 16 the *difference* annexed to the first branch (being the rate of the Wheat) is to 4 the *difference* annexed to the next, being the rate of the Rie; So is 10 the given quantity of the Wheat to another number, which being found by the rule of *Three direct* to be 2 $\frac{8}{16}$ (that is 2 bushels and an half) is the quantity of Rie necessary in the *mixture*.

II. As 16 to 8, so is 10 to another Number, which being likewise found by the Rule of *Three* to bee five bushels, is the quantitie of Barley; necessarie in the *mixture*.

III.

III. As 16 to 20, ſo is 10 to another Number, which being in like ſort found by the Rule of *Three* to be 12 $\frac{16}{32}$ (that is 12 buſhels and halfe of a buſhell) is the quantity of Oates requiſite in the *mixture*.

So that at laſt I conclude a *heap* of Corne being compoſed of 10 buſhels of Wheat, 2 $\frac{1}{2}$ buſhels of Rie, 5 buſhels of Barley, and 12 $\frac{1}{2}$ buſhels of Oates (when thoſe ſeverall Graines beare the *prices* aforeſaid) may be afforded at 2 s. 4 d. the buſhell.

2. Case. 2. The ſame *Example* being ordered after the ſecond manner (expreſſed likewiſe in the ninth rule of this preſent Chapter) *I ſay*;

I. As 4 the *difference* annexed to the *rate* of the Wheat, is to 16 the *difference* annexed to the *rate* of the Rie; ſo is 10 the *given* quantity of the Wheat, to 40 buſhels the *required* quantity of the Rie.

II. As 4 to 20, ſo is 10 to 50 buſhels, the *requiſite* quantitie of the Barley.

III. As 4 to 8, ſo is 10 to 20 buſhels, the quantity of the Oates *neceſſary* in the mixture.

28	48		4
	36		16
	24		20
	12		8

So that I conclude *again*, a maſs of Corn being compounded of 10 buſhels of wheat, 40 buſhels of Rye, 50 buſhels of Barley, and 20 buſhels of Oats, (when thoſe grains bear the prices propounded in this *example*) may be afforded at 2 s. 4 d. the buſhel, as *before*.

3. That example being diſpoſed after the third manner (expreſſed in the 10 and 11 rules of this chapter) I ſay; 3 Caſe.

I. As 20 the *ſum* of the differences annexed to the *rate* of the Wheat, is to 20 the *ſum* of the differences annexed to the *rate* of the Rye; ſo is 10 the *given* quantity of the wheat, to 10 buſhels the *required* quantity of the Rye.

II. As 20 to 28, ſo is 10 to 14 buſhels the *requiſite* quantity of the barley.

III. As 20 to 28, ſo is 10 to 14 buſhels, the quantity of Oats *demanded* in the mixture.

28	48	16. 4	20
	36	16. 4	20
	24	20. 8	28
	12	20. 8	28

Whereupon this *third time* likewise I conclude, that (those grains still retaining the given rates) 10 bushels of Wheat, 10 bushels of Ry, 14 bushels of Barley, and 14 bushels of Oats being all *mixed* together, will constitute a *mass* of Corn, that may be afforded at 28 d. or 2 s. 4 d. the bushel.

By this example thus *diversified* it plainly appears, that the quantities *required* may be altered as often, as the question given will admit divers *Alligations*, and yet the *mixture* produced will still hold the *rate* propounded; but when the *question* propounded will admit but one onely way of *Alligation*, the quantities required to make the *mixture*, cannot be varied; so the second *example* of the 10 rule of this Chapter being again produced, and ordered according to the direction of the 11 rule aforegoing, *I say*,

I. As to 4 to 4, so 10 to 10 bushels of Rye.

II. As

II. As 4 to 4, so 10 to 10 bushels of Barley.

III. As 4 to 60, so 10 to 150 bushels of Oats.

16	48	4	4
	36	4	4
	24	4	4
	12	32. 20. 8.	60

So that for this question *I conclude*, to 10 bushels of Wheat you ought to adde 10 bushels of Rye 10 bushels of Barley, and 150 of Oats, to the end that a *mixture* of Corn might be made, which may be sold at 16 d. the bushel: And here the quantities found (*viz.* 10, 10, and 150) cannot be *altered*, because the termes of this question will not admit any other variety of *Alligation*.

XV. *In Alternation partial, the proof is likewise by comparing the total value of the several simples, with the value of the whole mixture*: So in the second *example* of the last Rule the total *value* of the 10 bushels of Wheat, 40 bushels of Rye, 50 bushels of Barley, and 20 bushels of Oats amounts to 14 l. which is also the value of the whole mixture at 2 s. 4 d. the bushel, The Proof.

Q 2 as

as appears by the *example* of the fifth rule of this present Chapter.

Alternation Total. XVI. *Alternation total is, when having the total quantity of all the simples together with their several rates, we produce their several quantities, in such sort, that a mixture of them being made according to the quantities so found, that mixture may bear a certain rate propounded:* Of this sort is the last *example* of the tenth Rule aforegoing; as also *this*, A Goldsmith having divers sorts of Gold, *viz.* some of 24 carects, other of 22 carects, some of 18 carects, and other some of 16 carects *fine*, is desirous to melt of all these sorts so much together, as may make a *mass* containing 60 ounces of 21 carects *fine*: Now this Rule of *Alternation total* sheweth you how much you are to take of each sort, to the end the whole *masse* may contain just 60 ounces of 21 carects, the *finesse* propounded.

The Proportions. XVII. *In questions of Alternation total the Proportion is, as followeth;*

As the sum of all the differences is to the total quantitie of all the simples:
So is the correspondent difference of each rate to the respective quantity of the same rate.

So

So the last *example* of the last Rule being propounded, *I say,*

I. As 12 the sum of the differences is to 60 ounces the *Total* quantity of all the simples; so is 5 the correspondent *difference* of 24 carects the first rate, to 25 ounces, *viz.* the required quantity of the Gold of the same rate, which may be taken to make the *mixture* propounded.

II. As 12 to 60, so is 3 the correspondent *difference* of 22 carects the second rate, to 15 ounces, *viz.* the quantity of the Gold of 22 carects that ought to be used in the *mixture*.

III. As 12 to 60, so is 1 to 5 ounces of the Gold of 18 carects *fine*.

IV. As 12 to 60, so is 3 to 15 ounces of the Gold of 16 carects *fine*, which are requisite to be taken for the *mixture* propounded.

21	24	5
	22	3
	18	1
	16	3
		12

Whereupon *I conclude* that 25 ounces of 24 carects *fine*, 15 ounces of 22 carects,

 5

5 ounces of 18 carects, and 15 ounces of 16 carects *fine*, being all melted together will produce a *masse* of Gold containing 60 ounces of 21 carects *fine*, which is the resolution of the *question* propounded.

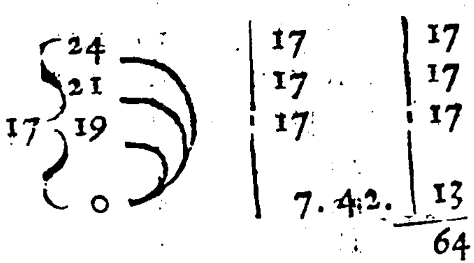
Again, the last *example* of the tenth Rule being here repeated, and ordered according to the direction of the eleventh Rule, *I say*,

I. As 64 to 120, so is 17 to 31 $\frac{56}{64}$ ounces of 24 carects *fine*.

II. As 64 to 120, so is 17 to 31 $\frac{56}{64}$ ounces of 21 carects *fine*.

III. As 64 to 120, so is 17 to 31 $\frac{56}{64}$ ounces of 19 carects *fine*.

IV. As 64 to 120, so is 13 to 24 $\frac{24}{64}$ ounces of *Alloy*.



And therefore for *conclusion* I say, that 31 $\frac{56}{64}$ ounces of Gold, 24 carects *fine*, 31 $\frac{56}{64}$ ounces of 21 carects *fine*, 31 $\frac{56}{64}$ ounces of 19 carects *fine*, and 24 $\frac{24}{64}$ ounces

ounces of *Alloy* being all mixed together, will produce a mass containing 120 ounces of Gold 17 carects *fine*, which is the satisfaction of the *question* premised.

And here *observe* (as before in the exposition of the fourteenth rule of this Chapter) that the operations of the first of these examples may be *varied* according to the diversity of the *Alligations* which it will admit, whereas the last example is not subject to any *variety*, the *Alligations* thereof remaining always the same.

XVIII. *Here the operation is perfect, when the sum of the quantities found agrees with the total quantity propounded:* So in the first *example* of the last rule, 25, 15, 5, and 15, (the quantities found) being all added together amount to 60, which is the total quantity propounded. The Proof.

CHAP. XXVIII.

The Rule of False.

Vide supra, cap. 2. rule 3.

I. T*Hus far Arithmetique Positive: Negative insues, which being also termed the Rule of False, is always performed by false and suppositial numbers formed by false and suppositial numbers afterwards invented, viz.* after the proposition is made, and the question propounded: For things are said to be found out by the *Rule of False,* when by false termes *supposed,* we *discover* the true terms *required.*

II. *The Rule of False is either of single or double position.*

The Rule of single Position.

III. *The Rule of single position is, when at once,* viz. *by one false position we have means to discover the true resolution of the question propounded.*

For example, A,B, and *C* determining to buy together a certain quantity of timber, that should cost them 36 l. agree amongst themselves that *B* shall pay of that sum a *third* part more then *A,* and that *C* shall pay a *fourth* more then *B.* Now the *question* is, what particular sum each

each of these parties ought to pay of the 36 l. To resolve this *question,* first, put the case that *A* ought to pay 6 l. of the 36 l. and then *B* must pay 8 l. because he payes $\frac{1}{3}$ more then *A.* And lastly *C* ought to pay 10 l. because he is to lay out $\frac{1}{4}$ more then *B.* This done, although by addition of these three sums, *viz.* 6, 8, and 10, I finde that I have made a wrong *position* (their totall amounting onely to 24 l. which ought to have been 36 l.) neverthelesse by those *suppositiall* Numbers, I have means to discover the true sums which the severall parties ought to pay: for *I say* by the rule of *Three Direct,*

I. As 24 to 36, so is 6 to 9 l. the *part* that *A* must pay.

II. As 24 to 36, so 8 to 12 l. the *part* that *B* ought to pay.

III. As 24 to 36, so is 10 to 15 l. the *part* of the 36 l. that *C* must pay.

IV. *Here for triall of this Rule the totall of the sums found ought to accord with the sum given:* so in the example of the last rule, 9, 12, and 15 being all added together amount to 36, the *sum* propounded. *The proofe.*

The Rule of double Position.

V. *The Rule of double Position is, when two false Positions are supposed for the resolution of the question propounded.* As in this

this, A workman having thresht out 40 quarters of Graine (*part* thereof being Wheat, and the rest Barley) received for his labour 28 s. being paid after the rate of 12 d. for every quarter of Wheat, and 6 d. for each quarter of Barley: Now here the question is how many of those 40 quarters were Wheat, and how many Barley: Here therefore I first suppose at randome that there was 26 quarters of Wheat, and 14 of Barley, and then to discover whether I have guessed right or wrong, I finde how much money is due unto the workman at the rate of 12 d. the quarter of Wheat, and 6 d. the quarter of Barley, which I find to be 33 s. (*viz.* 26 s. for the 26 quarters of Wheat, and 7 s. for the 14 quarters of Barley) which he ought to have received, if my *supposition* had been right; but because it differs from 28 s. the true sum that he received, I perceive I have mist the marke, and therefore discovering how much I have er'd by finding the *difference* betwixt 28 s. and 33 s. I keep in mind 5 their *difference*, which is called the *first error* or the *error of the first Position:* Again, I propound for the *second Position*, that there was 30 quarters of Wheat, and 10 quarters of Barley; and then the *second error* I find to be 7; for there

there is then due to the workman for the 30 quarters of Wheat 30 s. and for the 10 quarters of Barley 5 s. in all 35 s. which differs from 28 s. the true sum that he received, 7 s. and here by these two *false Positions*, together with their *errors*, you may discover how many quarters of Wheat, and how many of Barley the workman thresht, as shall be farther explained by the *Rule following.*

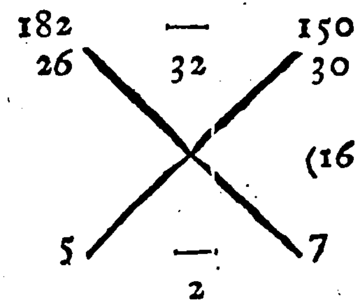
The Operation.

VI. *In the Rule of double Position having drawn two lines acrosse, and placed the termes of the false Position* (viz. *those that have the same Denomination) at the uppermost end of that crosse, as also each error under his respective Position at the lower end of the same crosse, multiply each error by the contrary Position; that is, the second error by the first Position, and the first error by the second Position; this done, when both the errors are of one and the same kind,* (viz. *both excesses or both defects) subtract the lesse Product out of the greater, and then the remainder is your Dividend; but if the errors be of differing kinds,* viz. *one of them an excesse, and the other a defect) add those Products together, and then the sum will bee your Dividend, which if you divide by the difference of the errors*

errors (when they are of one and the same kinde) or by their summe (when they are of differing kindes) the quotient will give you a number you looke for, having the same Denomination with the false Positions placed at the upper end of the crosse.

1. *Example*, The question of the last rule being againe propounded, I place these termes, *viz.* 26 (having the Denomination of the quarters of Wheat in the *first Position*) and 30 (having the same Denomination in the *second Position*) at the upper end of the *Crosse*: As also 5 and 7 the two errors respectively under them at the lower end of the same *Crosse*, as you may see it exemplified by the pattern *following*:

Note that this Character —— is a Signe of dissolution, signifying that the Numbers betwixt which it is found ought to be subtracted the one out of the other.

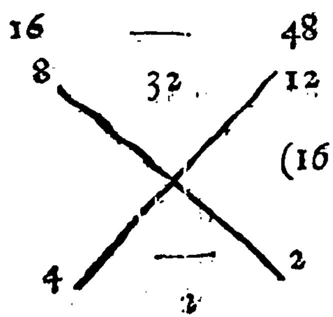


This done having multiplied 26 by 7, the *Product* is 182, and likewise 30 by 5 the

the *Product* is 150, which being deducted out of 182 (because the *errors* here are both of the same same kinde, *that is*, are each of them an *excesse* above 28 s. the summe that the workman received) the *remainder* is 32, which being divided by 2 (the difference betwixt 5 and 7 the two errors) leaves in the *quotient* 16, for the quarters of *Wheat* that the workman thresht, whose complement to 40, *viz.* 24. are the quarters of *Barley*, that he likewise thresht: so at last I conclude, the workman receiving 28 s. for his wages in threshing out 40 quarters of grain (being part Wheat, part Barley) at 12 d. the quarter of Wheat, and 6 d. the quarter of Barley, threshed in all 16 quarters of Wheat, and 24 quarters of Barley.

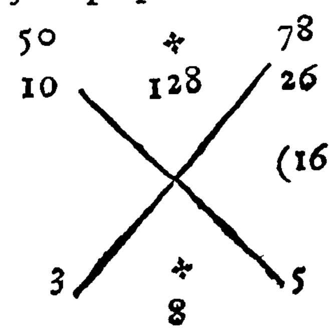
2. *Example*, the same question being again propounded, I suppose for my *first Position* that there are 8 quarters of Wheat, and 32 quarters of Barley, and then the *first error* will be 4 s. for 8 s. being accompted for the eight quarters of Wheat, and 16 s. for the 32 quarters of Barley, make in all 24 s. which wants 4 s. of 28 s. the sum received: Again, *supposing* that there are 12 quarters of Wheat, and 28 quarters of Barley, the *second error* will be

be 2 s. for 12 s. being allowed for the 12 quarters of Wheat, and 14 s. for the 28 quarters of Barley, the ſum is 26 s. which comes 2 s. ſhort of 28 s. the right ſumme: Now then 8 being multiplied by 2, the *Product* is 16, likewiſe 12 by 4 *produceth* 48, out of which if you deduct 16 (becauſe *the errors* in this caſe happen to bee both *defects* under 28 s. the ſum received) the *remainder* is 32, which being divided by 2 (the difference of the errors) gives you in the quotient 16, *viz.* the quarters of wheat, *as before*:



3. *Example*, the ſame demand being the third time produced, I take for my *firſt Poſition* 10 quarters of Wheat, and 30 quarters of Barley, and then proceeding as before, the *firſt error* will prove 3 s. which upon that *Poſition* I want of 28 s. the right ſum:

ſum: Again, here for the *ſecond Poſition* I take 26 quarters of Wheat, and 14 quarters of Barley, and then the *ſecond error* will be 5 s. which upon that *Poſition* I have exceeded 28 s. the true ſumme: Now then multiplying 10 by 5, the *Product* is 50, and 26 by 3, the *Product* is 78: And here (becauſe the *errors* are of differing kinds, one of them being a *defect*, and the other an *exceſſe* of 28 s. the true ſumme) you are to adde 50 and 78 the two *Products* together, whoſe ſum is 128, which being divided by 8 the ſum of 3 and 5 the two *errors*, gives you in the quotient 16 for the quarters of Wheat, *as before* in the former reſolutions. So that what *Poſitions* ſoever you take in this *Queſtion*, you ſhall alwayes finde, that the workman threſhed 16 quarters of Wheat, and 24 quarters of Barley, which is the reſolution of the *queſtion* propounded.



Note that this Character ✢ is a ſigne of connexion, intimating that the numbers betwixt which it is found, ought to be added together.

VII.

VII. *Here the triall is the same with that which is used in finding out the errors:* So in the *example* premised 16 and 24 being the numbers found, and 16 s. being allowed for the 16 quarters of Wheat, likewise 12 s. for the 24 quarters of Barley, their sum is 28 s. which was the sum received by the *workman*.

Thus have we past through all the chief parts of *Naturall Arithmetique*, in the exemplification whereof we have been the briefer, because we shall have occasion to use varieties of *examples* in the second Book, which treateth of *Artificiall* or *Logarithmeticall Arithmetique*, whereby you may resolve any question propounded in *broken* and *mixt* numbers, with little more difficultie then those propounded in *whole* numbers, as shall be further declared in the second Book.

An Appendix.

CHAP. I.

Of Rules of Practice, or Compendious Operations in the Rule of Three.

I. IN the *Rule* of *Three* as well *Direct* as *Inverse*, when the *Divisor* with either of the other two *termes*, may be divided by some *common measure* without leaving any *remainder*, the *quotients* may be taken for new *termes*; and proceeding in like manner as often as is possible, the Operation according to the ninth *Rule* of the one and twentieth Chapter; or the 2^d^ *Rule* of the two and twentieth Chapter, will be much contracted, as is manifest by the subsequent *Examples*.

Question I. If 14 yards of cloth cost 21 l. what will 52 yards cost at that rate? *Facit*, 78 l.

y.	*l.*	*y.*
14	21	52
2	3	52
1	3	26

Facit 78 *pounds.*

In the aforesaid Operation you may observe, that the *Divisor* 14 and the second *terme* 21 being divided by their common measure 7, the three termes will be 2,3,52; Again, the *Divisor* 2, and the *third terme* 52, being contracted by their *common measure* 2, the three *termes* will be 1,3,26; Lastly, proceeding according to the 9th. rule of the 21th. Chapter, the fourth proportionall or answer of the question will be found 78.

Quest. 2. If 21 *Men* will finish a work in 16 dayes, in what time will 12 *Men* perform the same?

Facit 28 dayes.

Men	*Dayes*	*Men.*
21	16	12
7	16	4
7	4	1

Facit 28 *dayes.*

By the aforesaid Operation you may observe

observe, that the *Divisor* 12, and the *first terme* 21, being contracted by 3, the three termes will be 7,16,4; Again, the *Divisor* 4, and the *second terme* 16, being contracted by 4, the three terms will be 7,4,1. Lastly, working by the 2d *Rule* of the 22. *Chapter*, the answer of the question will be found 28 *dayes.*

II. In the *Rule* of *Three Direct* or *Inverse*, when the *Divisor* and either of the other two *termes* are Fractions having a common *Denominator*, the said *Denominators* may be rejected and the *Numerators* retained as *new termes.*

Question 3. If $\frac{3}{8}$ of an Ell of *Sattin* be worth 5 s. 6 d. what is the value of $\frac{7}{8}$ of an Ell of the same *Sattin*?

Facit 12 s. 10 d.

$\frac{3}{8}$	5 s. 6 d.	$\frac{7}{8}$
3	66	7
1	22	7

Facit 154 *pence* or 12 s. 10 d.

Question 4. If 3 $\frac{3}{4}$ yards of *Scarlet* cost 8 l. 15 s. what is the price of one yard at that rate?

Facit 2 l. 6 s. 8 d.

$\frac{15}{4}$ —— $\frac{35}{4}$ —— 1

15 —— 35 —— 1

3 —— 7 —— 1

Facit $2\frac{1}{3}$ l.

I might proceed to shew divers briefe Operations in the *Rule* of *Three*, where one of the *Termes* is 1 or unity, which Contractions will bee obvious to such as are exercised in *Arithmetique*, and skilfull in *Proportion*, but would bee as a wildernesse of *Rules* to *Learners*, and therefore I shall onely mention a few *examples*, some of which may bee practised by the ingenious, although they have but little knowledge in *Arithmetique*, and may bee sufficient to inform them how to resolve other questions of like nature.

Question 5. At 17 s. 9 d. the yard, what will 84 yards cost?

Facit 74 l. 11 s.

Here reason sheweth that 84 yards must cost 84 *Angels*, 84 *Crownes*, 84 *halfe Crownes*, and 84 *three-pences*; all which being computed and added together, will give the full cost of 84 yards.

	l. s. d.
84 *Angells* make ——	42-00-00
84 *Crownes* make ——	21-00-00
84 *Half-Crowns* make ——	10-10-00
84 *Three-pences* make ——	1-01-00
Summe	74-11-0

Question 6. At 9 s. the *Bushell* of *Wheat*, what will 51 *quarters* amount unto? *Facit* 183 l. 12 s. 0 d.

First finde the price of 1 *quarter* which will be 8 *Angells* wanting 8 *shillings*, viz.

	l. s. d.
8 *Angells* make ——	4-00-00
Out of which deduct ——	0-08-00
Rem. the price of 1 *quart.*	3-12-00

Then finde what 51 *quarters* will amount unto at 3 l. 12 s. 0 d. the *quarter*, thus,

	l. s. d.
51 times 3 l. or 3 times 51 l. is	51-00-00
	51-00-00
	51-00-00
51 *Angels* make ——	25-10-00
51 *shillings* doubled make ——	5-02-00
The price of 51 *quarters*	183-12-00

Tare is that wherein any thing is put; as a bag for pepper, a chest for sugar, &c.

Question 7. What is a Chest of *Sugar* worth, that waigheth neat waight (the *Tare* being subtracted) 7 $\frac{3}{4}$ C. 7 lb. at 6 l. 3 s. 4 d. the C?

Facit 48 l. 3 s. 6 $\frac{1}{2}$ d.

	l. s. d.
7 times 6 *pounds* make ——	42-00-00
7 times 3 *shillings* make ——	1-01-00
7 *groats* make ——	0-02-04
The halfe of 6 l. 3 s. 4 d. for $\frac{1}{2}$ C. is ——	3-01-08
The halfe of 3 l. 1 s. 8 d. for $\frac{1}{4}$ C. is ——	1-10-10
The fourth part of 1 l. 10 s. 10 d. (because 7 lb. make $\frac{1}{4}$ of 28 pounds or $\frac{1}{4}$ C.) is ——	0-07-08$\frac{1}{2}$
	48-03-06$\frac{1}{2}$

Rules of *Practice* in this kinde will bee the readier, if some few Notions in relation to *English Coines* be retained in memory, *viz.* such as are exprest in the subsequent *Table*.

		l. s. d.
20 *Groats*	make	0-06-8 or a *Noble*.
40 *Groats*	make	0-13-4 or a *Marke*.
60 *Groats*	make	1-00-0 a *pound Sterling*.
120 *Groats*	make	2-00-0
180 *Groats*	make	3-00-0
240 *Groats*	make	4-00-0
300 *Groats*	make	5-00-0
100 *Shillings*	make	5-00-0
1000 *Shillings*	make	50-00-0
60 *Pence*	make	0-05-0 A *Crown*.
120 *Pence*	make	0-10-0 An *Angell*.
240 *Pence*	make	1-00-0

The benefit of the said *Table* will bee partly manifest by the two subsequent *examples*.

Question 8. At 7 d. the pound of *Currants*, what will 1 C. 8 lb. or 120 lb. amount unto?

Facit 3 l. 10 s.

	l. s. d.
120 *Three-pences*, or 60 *six-pences*, or 30 *shillings* make ———	1-10-00
120 *Groats*, make ———	2-00-00
	3-10-00

Question 9. At 14 $\frac{1}{2}$ d. the pound of *Sugar*, what will 1200 pounds amount unto?

Facit 72 l. 10s.

	l. s. d.
1200 *Shillings* make ———	60-00-00
1200 *Two-pences* or 600 *Groats* make ———	10-00-00
1200 *Halfe-pence*, or 600 *pence*, or 300 *two-pences*, or 150 *Groats* make ———	2-10-00
	72-10-00

Thus far a reasonable capacity may go, without multiplying or dividing, unlesse by doubling or halving, but such which can Multiply or Divide, may make more expedition as will be manifest by the subsequent *examples*.

Question

Question 10. In 1000 *Marks English*, how many pounds *Sterling*?

Facit 666 l. 13 s. 4 d.

For since 1000 *Marks* are equall unto 2000 *Nobles*, and three *Nobles* make a pound *Sterling*, therefore $\frac{1}{3}$ of 2000, *viz.* 2000 divided by 3, quoteth *666* $\frac{2}{3}$ l. that is *666* l 13 s. 4 d.

Question 11. At 14 s. 8 d. the pound of *Tobacco*, what will 573 pounds amount unto?

Facit 420 l. 4 s.

Since in 14 s. 8 d. (the price of 1 lb. waight) there is contained $\frac{1}{2}$ l. *Sterling*, $\frac{1}{5}$ l. also $\frac{1}{2}$ s. and $\frac{1}{6}$ s. therefore,

	l. s. d.
$\frac{1}{2}$ of 573 is 286 $\frac{1}{2}$ l. or —	286-10-00
$\frac{1}{5}$ of 573 is 114 $\frac{3}{5}$ l. or —	114-12-00
$\frac{1}{2}$ of 573 is 286 $\frac{1}{2}$ s. or —	14-06-06
$\frac{1}{6}$ of 573 is 95 $\frac{1}{2}$ s. or —	4-15-06
	420-04-00

Question 12. At 5 l. *per Centum*, what must be allowed for 850 l. 18 s. 7 d?

Facit 42 l. 10 s. 11 $\frac{3}{20}$ d.

Observe

Observe the Operation in the *Margent*, and find first of all how much 5 times 850 l. 18 s. 7 d. will amount unto, in manner following, *viz.* 5 times 7 pence make 2 s. 11 d. which 11 d. is to bee placed underneath the line as you see, and the 2 s. are to be reserved in mind;

```
  l.    l.    l.   s. d.
 100 — 5 — 850. 18. 7
                     5
 li. 42|54.  12. 11
        |20
 s.  10|92
        |12
       195
        92
 d.  11| 15 |3
       |100 |20
```

Again, 5 times 18 shillings, make 90 s, which with 2 s, in minde make 4 l, 12 s, which 12 s, are to bee placed underneath the line as you see, and the 4 l, are to bee reserved in mind; again multiplying 850 l, by 5, and unto the Product adding 4 l, in mind, the sum will be 4254 l: so the totall Product is found to be 4254 l, 12 s, 11 d. which is to bee divided by 100 (the first Terme in the Rule) in this manner, *viz.* begin with the said 4254 l, and divide the same by 100, which is performed by cutting off two places towards the right hand, so

so will the Quotient bee 42 pound, and there will remaine 54 pound, which remainder being Multiplied by 20 shillings, and the 12 shillings standing in the place of shillings taken in to the Product, the aggregate will bee 1092 shillings, which being divided by 100, (in cutting off two places towards the right hand) the quotient will be tenne shillings, and there will remain 92 shillings, which remainder being multiplied by 12 pence, and the 11 d, standing in the place of pence taken into the Product, the aggregate will bee 1115 pence; which being divided by 100, in cutting off two places towards the right hand as before, the quotient will bee 11 $\frac{15}{100}$ d. that is, (the Fraction being abbreviated) 11 $\frac{3}{20}$ d. So the answer of the question is found as you see 42 l, 10 s, 11 $\frac{3}{20}$.

Question 13. At 6 l, 15 s, *per Centum*, what doth 2156 l, 13 s, 4 d. amount unto?

Facit 145 l, 11 s, 6 d.

After the manner of the last *Example*, Multiply the said 2156 l, 13 s, 4 d. by 6, and place the Product which is

is 12940 underneath the line as you see, then since 15 s, are equall unto $\frac{1}{2}$ l. together with $\frac{1}{4}$ l, take therefore $\frac{1}{2}$ also $\frac{1}{4}$ of the said, 2156 l, 13 s, 4 d. and adde those quotients to the Product first found, then proceed with the aggregate, according to the twelfth *question*: So will you finde the answer of this question to be 145 l, 11 s, 6 d.

```
       l.    s.  d.
     2156. 13. 4
                6
    12940. 00. 0
     1078. 06. 8
      539. 03. 4
l. 145|57. 10. 0
      |20
s.  11|50
      |12
      100
       50
d.   6|00
```

Question 14. At 8 pounds *per Centum, per An.* what doth 3546 l, 15 s, 6 d. amount unto for 10 moneths?

Facit 236 l, 9 s, $\frac{2}{5}$ d.

After the manner of the 12 *question*, Multiply the said 3546 l, 15 s, 6 d. by 8, and place the Product underneath the line as

as you see then since 10 months are equall unto $\frac{1}{2}$ yeare together with $\frac{1}{3}$ yeare, take therefore $\frac{1}{2}$ also $\frac{1}{3}$ of the aforesaid Product, and adde the said quotients together.

Lastly, proceede with the aggregate, according to the directions in the twelfth *question*. So will you finde the answer of this *question* to bee 236 l, 9 s, $\frac{2}{5}$ d.

```
        l.    s.  d.
      3546. 15. 6
                 8
     28374. 04. 0
     14187. 02. 0
      9458. 01. 4
li. 236|45. 03. 4
       |20
s.    9|03
       |12
        40 |2
       100 |5
```

CHAP.

CHAP. II.

Of exchange of Coines, Waights and Measures.

THe *Rate* or *Proportion* between Coins, Waights and Measures of different kinds being knowne, either from some good Author, or rather by experience, it will be easie for such as understand the *Rule* of *Three*, to convert one *Species* into another according to the manner of Operation in the following *examples*.

See the Merchants Map of commerce.

Question 1. Unto how much *sterling* money do 1234 *Francs* or pounds *Tournois* amount at 2 s. *sterling* the pound *Tournois*? *Facit* 123 l. 8 s. *sterling*.

1 l. *Tourn.*—2 s. *Ster.*—1234 l. *Tourn.*
Facit 123 l. 8 s. *Sterling*.

Question 2. How many *Ryders* at 1 l. 1 s. 2 ½ d. *Sterling* the piece, ought to be received for 251 l. 6 s. 4 ½ d. *Sterling*?
Facit 237 *Ryders*.

1 l. 1 s. 2 ½ d. *Ster.*—1 *Ryder*-251 l. 6 s. 4½ d.
Sterling. *Facit* 237.

Question

Question 3. How many *Quart d' Escus* ought to be received for 28 l. *sterling*, when 5 *Quart d' Escus* are 8 s. *sterling*? *Facit* 350.

8——5——560
1——5——70
Facit 350 *Qu. d' Escus*.

Question. 4. How many *Spanish Pistolets* at 14 $\frac{2}{5}$ s. *sterling* the piece, ought to be received for 120 *Escus d' or* at 7 $\frac{3}{5}$ s. *sterling* the piece?
Facit 62 $\frac{24}{73}$ *Spanish Pistolets*.

This question and such like may be resolved by two single *Rules* of *Three*, as is manifest by the following operation.

I. 1 *Escus d' or*— 7 $\frac{3}{5}$ s. *sterling*—120 *Escus d' or*.
Facit 45 l. 12 s. *sterling*.

II. 14 $\frac{2}{5}$ s. *ster.*—1 *Span. pist.*—45 l. 12 s. *sterling*.
Facit 62 $\frac{24}{73}$ *Spanish pistolets*.

Otherwise by one single *Rule* of *Three*, the termes being ordered as followeth; viz.

As the value of one piece of the Species sought,

sought, is to the number of pieces given to be reduced; so is the value of one piece of the Species given, to the number of pieces of the Species sought.

$14\frac{3}{5}$ s. *sterl.* — 120 *Escus d'or* — $7\frac{3}{5}$ s. *ster.*
73 —— 120 —— 38
Facit 62 $\frac{34}{73}$ *Spanish pistolets*, as before.

Question 5. If $\frac{1}{2}$ *Pistolet* of *Spain*, be valued at 3 l. 13 s. 6 d. *Tournois*; 6 l. *Tourn.* at 14 s. *Flemish*: and 28 l. 14 s. 7 d. *Flemish*, at 24 l. 12 s. 6 d. *sterling*, How many *Pistolets* ought I to receive for 72 l, 6 s, 9 d. *sterling*? *Facit* 98 $\frac{41}{98}$ *Pistolets.*

I. 3 l, 13 s, 6 d. *Tourn.* — $\frac{1}{2}$ *Pist.* — 6 l. *Tou.*
Facit $\frac{40}{49}$ *Pistol.* equall unto 14 s. *Flem.*

II. 14 s. *Flem.* — $\frac{40}{49}$ *Pist.* — 28 l, 14 s, 7 d. *Flemish.*
Facit 33 $\frac{74}{147}$ *Pistolets*, equall unto 24 l, 12 s, 6 d. *sterling.*

III. 24 l, 12 s, 6 d. *sterling*, —— 33 $\frac{74}{147}$ *Pist.* —— 72 l, 6 s, 9 d. *sterling.*
Facit 98 $\frac{41}{98}$ *Pistolets.*

Question 6. Unto how much (*Troy* waight) doe 5 C. 3 qu, 17 lb. (*Averdupois* waight) amount; when the lb. *Averdupois* makes 1 lb. 2 Oun. 12 pen. *Troy*?
Facit 804 lb. 2 Oun. 12 pen.

1 lb. *Averdupois*, — 1 lb. 2 Oun. 12 p. *Troy* —— 5 C. 3. qu. 17 lb. *Averdupois.*
Facit 804 lb. 2 Oun. 12 pen.

Question 7. How much waight at *Rouan* doe 365 lb. *Averdupois* make, when 100 lb. at *Rouan*, make $114\frac{1}{4}$ lb. *Averdupois*? *Facit* 319 $\frac{212}{457}$ lb. of *Rouan.*

$114\frac{1}{4}$ —— 100 —— 365 —— (319 $\frac{212}{457}$

Question 8. If 100 *Ells* of *Antwerpe* make 75 *yards* of *London*, how many *yards* of *London* measure, will $\frac{1}{4}$ 27 *ells* of *Antwerpe* make? *Facit* 20 *yards.*

100 —— 75 —— 27 —— (20 $\frac{1}{4}$.

Question 9. How many *yards* of *London*, make 27 *ells* of *Antwerpe*, when 100 *ells* of *Antwerp* make 60 ells of *Lyons*, and 20 *ells* of *Lyons* make 25 *yards* of *London*?

ells Ly. *yards Lon.* *ells Ly.*
I. 20 —— 25 —— 60
Facit 75 *yards* of *London*, equall unto 100 *ells* of *Antwerpe.*

S *Ells*

Ells Antw. *yards Lond.* *ells Antw.*
II. 100 ——— 75 ——— 27
Facit 20 $\frac{1}{4}$ *yards* of *London.*

Question 10. How many *ells* of *Frankefort* make 42 $\frac{1}{4}$ *ells* of *Vienna* in *Austria*, when 35 *ells* of *Vienna* make 24 at *Lyons*; 3 *ells* of *Lyons*, 5 *ells* of *Antwerpe*; and 100 *ells* of *Antwerpe*, 125 *ells* at *Frankefort*?
Facit 60 $\frac{5}{14}$ *ells* of *Frankefort.*

Ells Antw. *ells Frank.* *ells Antw.*
I. 100 ——— 125 ——— 5
Facit 6 $\frac{1}{4}$ *ells* of *Frankefort*, which are equall to 3 *ells* of *Lyons.*

Ells Ly. *ells Fran.* *ells Ly.*
II. 3 ——— 6 $\frac{1}{4}$ ——— 24
Facit 50 *ells* of *Frankefort*, which are equall unto 35 *ells* of *Vienna.*

Ells Vien. *ells Fran.* *ells Vien.*
III. 35 ——— 50 ——— 42 $\frac{1}{4}$
Facit 60 $\frac{5}{14}$ *ells* of *Frankefort.*

Such which have much practice in *exchanges*, and know what *proportion* the *Coines*, *Waights* and *Measures* of any *Countrey* or *City* doe beare unto those of another,

another, may by the *Rule of Three*, frame *Tables* for their owne use, therein expressing the *proportions* in such manner, that the first Terme or *Antecedent*, of each *proportion*, may bee 1 or unity, and the *consequent* or second terme a *Decimall*, or else a mixt number, whose Fractionall part may be a *Decimall*, for then the *Coine*, *Waight*, &c. of the one place, (whose terme is 1) may bee reduced into that of the other place, by help of those *Tables* and of *Multiplication* of *Decimalls* without sensible error: For *example*, It hath beene observed by some ingenious *Merchants*, that 100 lb. of *Averdupois* waight at *London*, are equall unto 89 lb. in *Paris* by the *Kings beam*, and consequently 1 lb. *Averd.* is equall to $\frac{89}{100}$ lb. or .89 lb. at *Paris*, (for if 100 give 89, then 1 will give .89) therefore any number of pounds *Averdupois* being multiplied by .89 (with respect unto *Multiplication* of *Decimalls*, explained in the fifteenth Chapter of the preceding Book) will produce pounds of *Paris*: Again, if 89 lb. of *Paris* bee equall to 100 lb. *Averdupois*, then 1 lb. of *Paris* will bee equall to 1. 1235 lb. of *Averdupois*; therefore any number of pounds of *Paris* being multiplied by

1.1235 will produce pounds *Averdupois*.

Vpon this ground I have collected the proportions in the subsequent *Tables*, wherein I would not have any to confide further then they shall know them to bee agreeable to truth, for I have onely derived them from those delivered by Master *Lewes Roberts Merchant*, in his *Map of Commerce*, and doe herein onely aime at the instruction of ingenious *Merchants* and *Factors* in the briefest wayes of calculating their *exchanges*, the *rate* or *proportion* being truely knowne; in which practice, *Decimall Arithmetique* (which hath no enemy but the Ignorant.) will be very serviceable.

A Table

A Table for the Reduction of Averdupois *waight at* London, *to the waights of divers forreign Cities and remarkable places.*

		lb.
One pound of *Averdupois* waight at *London*, makes at	ANtwerpe,	.9615
	Amsterdam	.9
	Abbeville,	.91
	Ancona,	1.282
	Avignon,	1.12
	Burdeaux,	.91
	Burgoyne,	.91
	Bollonia,	1.25
	Bridges,	.98
	Callabria,	1.3698
	Callais,	1.07
	Constantinople,	.8474 *Loder*;
	Deepe,	.91
	Dansicke,	1.16
	Ferrara,	1.3333
	Florence,	1.282
	Flanders in general	1.06
	Geneva,	.9345

 Genoa,

		lb.	
One pound of *Averdupois* waight at *London*, makes at	*Genoa*,	1 . 4084	*suttle*
		1 . 4285	*grosse*,
	Hamburg	. 92	
	Holland,	. 95	
	Lixborne,	. 881	
	Lyons,	1 . 07	cōmon wt.
		. 98	silke wt.
		. 9	custōers wt.
	Leghorn,	1 . 3333	
	Millan,	1 . 4285	
	Mirandola,	1 . 3333	
	Norimberg	. 88	
	Naples,	1 . 4084	
	Paris,	. 89	
	Prague,	. 83	
	Placentia,	1 . 3888	
	Rotchell,	1 . 12	
	Rome,	1 . 27	
	Rouan,	. 875	by vicōt
		. 9017	com. wt.
	Sivill,	1 . 08	
	Tholousa,	1 . 12	
	Turin,	1 . 2195	
	Venetia,	1 . 5625	suttle
		. 9433	grosse
	Vienna,	. 813	

The

The use of the preceding *Table* will be manifest by the subsequent *example*.

Question 11. How much waight at *Dansick* doe 320 lb. *Averdupois* make? *Facit* 371.2 lb. Seeke in the precedent *Table* for *Dansick*, and right against it you shall finde 1. 16 which shewes that 1 lb. *Averdupois* is equall to 1 .16 lb. at *Dansick*, therefore multiply 320 by 1. 16, so will the Product be 371. 2 lb. of *Dansick* as by the Operation is manifest.

If 1 lb. *Aver.*–1 ,16 lb. *Dans.*–320 lb. *Aver.*

```
      1.16
    ------
      1920
      320
     320
    ------
     371|20
```

 A Table

A *Table for the Reduction of the waights of divers forreigne Cities and remarkable places* to Averdupois *waight at* London..

One pound waight in	makes at *London* of *Averdupois* waight lb.
ANtwerpe	1.04
Amsterdam	1.1111
Abbeville	1.0989
Ancona	.78
Avignon	.8928
Burdeaux	1.0989
Burgoyne	1.0989
Bollonia	.8
Bridges	1.0204
Calabria	.73
Callais	.9345
Deepe	1.0989
Dansick	.862
Ferrara	.75
Florence	.78
Flanders in generall,	.9433
Geneva	1.07
Genoa suttle,	.71
Genoa grosse :	.7

Ham-

One pound waight in	makes at *London* of *Averdupois* waight lb.
Hamburg	1.0865
Holland	1.0526
Lixborne	1.135
Lyons cōmon w^t^.	.9345
Lyons silke w^t^.	1.0204
Lyons custom w^t^.	1.1111
Leghorne	.75
Millan	.7
Mirandola	.75
Norimberg	1.1363
Naples	.71
Paris	1.1235
Prague	1.2048
Placentia	.72
Rotchell	.8928
Rome	.7874
Rouan by Vicont,	1.1428
Rouan cōmon w^t^.	1.1089
Sivill	.9259
Tholousa	.8928
Turin	.82
Venetia suttle,	.64
Venetia grosse :	1.06
Vienna	1.23

The

The use of the last mentioned *Table*, will be manifest by this *example*, viz.

Question 12. In 224 lb. waight at *Hamburg*, how many pounds *Averdupois?*

Facit 243.376 lb.

Seek in the *Table* for *Hamburg*, and right against it you will finde 1 .0865 which sheweth that 1 lb. of *Hamburg*, makes 1.0865 lb. of *Averdupois*; therefore if 1 .0865 bee multiplied by 224 the Product will be pounds *Averdupois*.

```
1 ——— 1.0865 ——— 224
                 224
              ------
               43460
              21730
             21730
           ---------
             243|3760
```

A Table

A Table for the Reduction of English ells to the Measures of divers forreigne Cities, and remarkable places.

One Ell at London, makes at		
Amsterdam	1.6949	Ells.
Antwerp	1.6666	Ells.
Bridges	1.64	Ells.
Arras	1.65	Ells.
Norimberg	1.74	Ells.
Colen	2.08	Ells.
Liste	1.66	Ells.
Mastrich	1.57	Ells.
Frankeford	2.0866	Ells.
Dansick	1.3833	Ells.
Vienna	1.45	Ells.
Paris	.95	Aulnes.
Rouan	1.03	Aulnes.
Lions	1.0166	Aulnes.
Callais	1.57	Aulnes.
Venice linnen,	1.8	Braces.
Venice silke:	1.96	Braces.
Lucques	2.	Braces.
Florence	2.04	Braces.
Millan	2.3	Braces.
Leghorne	2.	Braces.
Madera Isles	1.0328	

Sivill

One Ell at *London*, makes at	*Sivill*	1.35	
	Lisbone	1.	Vares
	Castilia	1.3875	Vares
	Andoluzia	1.3625	Vares
	Granado	1.3625	Vares
	Genoa	4.8083	Palmes
	Saragosa	.55	Canes
	Rome	.56	Canes
	Barselona	.7125	Canes
	Valentia	1.2125	Canes

The use of the aforesaid *Table* will be manifest by the subsequent *example, viz.*

Question 13. In 325 *ells* of *London*, how many *ells* at *Antwerpe?*

Facit 541.645 Ells: Seek in the *Table* for *Antwerp*, and right against it you shall find 1.6666 which being multiplied by 325 produceth 541.645 *ells* of *Antwerp*, as by the operation is manifest.

```
1 ——— 1.6666 ——— 325
          325
       ------
        83330
       33332
      49998
     --------
      541|6450
```


A Table for the Reduction of the Measures of divers forreign Cities, and remarkable places to English *ells.*

One Ell at	*AMsterdam*	makes at *London*	.59	Ells
	Antwerp		.6	
	Bridges		.6097	
	Arras		.606	
	Norimberg		.5747	
	Colen		.4807	
	Lisle		.6024	
	Mastrich		.6369	
	Frankeford		.4792	
	Dansicke		.7228	
	Vienna		.6896	
One Auln at	*Paris*		1.0526	
	Rouan		.9708	
	Lions		.9836	
	Callais		.6369	
One Brace at	*Venice* linnen		.5555	
	Venice silke		.5102	
	Lucques		.5	
	Florence		.4901	
	Millan		.4347	
	Leghorn		.5	
	Madera Isles		.9681	

One Vare at	*Sivill*	makes at *London*	.7407	Ells.
	Lisbone		1.	
	Castilia		.7207	
	Andoluzia		.7339	
	Granado		.7339	
One Palm at	*Genoa*		.2079	
One Cane at	*Saragosa*		1.8181	
	Rome		1.7857	
	Barselona		1.4035	
	Valentia		.8247	

The use of the said *Table* will bee manifest by the subsequent *example*, viz.

Question 14. In 730 *Aulnes* at *Lions*, how many Ells at *London*?

Facit 718.028. Seeke in the *Table* for *Lions*, and right against it you shall finde .9836 which being multiplied by 730 produceth 718. 028 Ells of *London*, as by the operation is manifest.

1 —— .9836 —— 730

```
   730
295080
68852
718|0280
```

Upon

Upon the same ground, *Tables* for *exchange of coins* may be calculated by such which know the exact Rate, which in respect of the rising and falling of *Moneys* in divers places I have omitted.

Chap. III.

Of Interest of money.

I. THe *propositions or questions concerning Interest of money, consist of 4 termes*, viz. *Capitall* or *Principall*: *Time*; *the proportion which the principall bears to the Interest*; *and the Interest it selfe*: So if 100 l, be delivered to the end that 108 l, may be repayed at the end of a yeare, the said 100 l, is called *principall*; one yeare is the *time* of forbearance thereof; the *proportion* which the *principall* bears to the *Interest* is as 100 to 8; and the said 8 l, is the *Interest*.

II. *Interest is either Simple or Compound.*

III. *Simple Interest, is that which ariseth or is computed from the principall onely*: So if 100l. be forborn two yeares, the *simple Interest* thereof after the rate of

8 pounds

8 pounds for 100 pounds for 1 yeare will be 16 pound, *viz.* 8 pound due at the first yeares end, and 8 pound due at the second yeares end.

IV. *Compound Interest is that which ariseth from the principall, and also from the Interest thereof, and therefore is called Interest upon Interest*: So if 100 pounds be forborn 3 yeares, and *compound Interest* thereof is to be computed after the rate of 8 pound *per centum, per annum*, there will arise besides the *simple Interest* of the *principall* for 3 yeares, the *Interest* of 8 pound (due at the yeares end) for 2 yeares, and the interest of 8 pound (due at 2 yeares end) for 1 yeare.

V. *Rebate or discompt of money is, when a summe of mony due at any time to come, is satisfied by the payment of so much present money, which being put forth at a certain rate of Interest for the said time, would become equall to the summe first due*: So if 100 pound bee due at the end of two yeares, and is to be satisfied by the payment of present money upon rebate, after the rate of 8 pound *per centum, per annum, simple Interest*, there ought to be so much ready money paid, which in two yeares after the said rate of Interest would be

bee augmented unto 100 pound. In like manner, if the rebate or discompt were to be made after any rate of *compound Interest*, so much ready money ought to be paid, which at the rate of *compound Interest* for the time agreed upon would become equall to the summe first due.

Questions of simple Interest.

Question 1. What is the *simple Interest* of 270 pound for one yeare after the rate of 8 l. for 100 l. for one yeare? *Facit* 21 l. 12 s.

See the Rules of Practice of this kind, in pag. 251.

If 100 —— 8 —— 270
Facit $21\frac{3}{5}$ l. or 21 l. 12 s.

Question 2. What is the *simple Interest* of 20 pounds for 3 yeares after the rate of 7 pound *per centum, per annum*? *Facit* $4\frac{1}{5}$ l.

y. l. y.
I. If 1 —— 7 —— 3 *Facit* 21 l.
l. l. l.
II. If 100 —— 21 —— 20 *Facit* $4\frac{1}{5}$ l.

Question 3. What is the *simple Interest* of 235 l. for 5 moneths and 5 dayes, (accounting 28 dayes to each moneth) after

ter the rate of 6 l. *per centum, per annum?*
Facit $5 \frac{439}{730}$ l.

	dayes.	*l,*	*dayes.*
I. If	365 ——	6 ——	145
or	73 ——	6 ——	29

Facit $\frac{174}{73}$ l.

	l,	l,	l.
II. If	100 ——	$\frac{174}{73}$ ——	235

Facit $5 \frac{439}{730}$ l.

Question 4. If an Annuity of yearly rent of 20 pounds bee forborn 4 yeares, what will it amount unto at the end of the said terme, allowing *simple Interest* after the rate of 7 l. *per centum per annum*, for each yeares rent, from the time at which it is due, untill the end of the said terme of 4 yeares?

It is evident by the question, that there must bee computed the *Interest* of 20 l. (due at the first yeares end) for the three following yeares; also the *Interest* of 20 pound (due at the second yeares end) for the two following yeares, and the *Interest* of 20 pound due at the third yeares end, for the yeare following, the summe of which *Interest* being added to the aggregate of the foure yeares rent, gives the summe

summe due, at the end of foure yeares.

	l,	l,	l.
If	100 ——	7 ——	20

Facit 1 l, $\frac{2}{5}$ the *Interest* of 20 l.
for 1 yeare;
therefore $2 \frac{4}{5}$ for 2 yeares,
$4 \frac{1}{5}$ for 3 yeares,
80 the sum of the foure yeares rent:
$88 \frac{2}{5}$ the totall sum due at the end of 4 years.

Question 5. How much ready money will pay 100 pounds due at the end of a yeare, rebating after the rate of 8 pound *per centum, per annum, simple Interest?*
Facit 92 l, 11 s, 10 $\frac{6}{27}$ d.

Adde 100 pound to its Interest 8 pound, so is the summe 108 pound; then it is evident that 108 pound due after the end of a yeare is equivalent to 100 pound ready money, according to the said rate of *Interest*; Therefore the proportion will be:

If 108 —— 100 —— 100
Facit $92 \frac{16}{27}$ l.

For as 100 pound ready money will be augmented to 108 pound at the yeares end;

end, so $92\frac{16}{27}$ pound ready money, will become 100 pound at the years end.

Question 6. How much present money will pay 315 pound due at the end of three moneths and eleven dayes, accounting twenty eight dayes to a moneth, and rebating after the rate of 7 pound *per centum per annum, simple Interest* ?

Facit $309\frac{2703}{7433}$ l.

The Interest of 100 pound for three moneths eleven dayes, will be found (after the manner of the third Question) to bee $1\frac{60}{73}$ pound, which added to 100 pound, gives $101\frac{60}{73}$ Then

As $101\frac{60}{73}$ — 100 — 315 ——

Facit $309\frac{2703}{7433}$ l.

Question 7. How much present money is equivalent to an Annuity or Rent of 100 pounds *per annum*, to continue five yeares, discompting after the rate of 6 pound *per centum, per annum, simple Interest* ?

Facit $425\frac{8286150}{88211267}$ l.

It is manifest that there must bee computed the present worth of 100 pound, due at the first yeares end; Also the present worth of 100 pound, due at the se-

cond

cond yeares end, and in like manner for the third, fourth, and fifth yeares; all which particular present worths being added together, will give the totall present worth of the Annuity, which may be performed in manner following, *viz.*

		l,	l,	l.
1	106 —	100 —	100 —	($94\frac{18}{53}$
2	112 —	100 —	100 —	($89\frac{2}{7}$
3	118 —	100 —	100 —	($84\frac{44}{59}$
4	124 —	100 —	100 —	($80\frac{20}{31}$
5	130 —	100 —	100 —	($76\frac{12}{13}$

Facit $425\frac{8286150}{88211267}$ l.

From the manner of Resolution of the last mentioned question, that *Rule* commonly called *Æquation of Payment* found in divers *Treatises of Arithmetique*, will be found erroneous, for the manifestation whereof, I shall propound as followeth;

A detection of the erroniousnesse of that Rule called *Æquation* of Payment, found in divers Treatises of Arithmetique, *viz.* in *Mastersons* Arithm. pag. 153. *Records* Arithmetique, pag. 493. *Johnsons* Arithmetique, pag. 208. and divers others.

1. Since that *rule* aimes at the reducing of severall dayes of payment, upon which particular summes of money are due, unto a mean time, upon which the aggregate or totall of those particular summes ought to be paid, without dammage to the *Debitor* or *Creditor*, there must be necessarily some

T 3 rate

rate of *Interest* implyed: otherwise, why may not any day at pleasure bee assigned for one intire payment.

2. If some *rate* of *Interest* be implied, then equity requires, that the present worth of the totall summe payable at one intire payment, *rebate* or *discompt* being made according to that *rate* of *Interest*, may bee equall to the aggregate or summe of the present worths of the particular summes of money, *rebate* being made according to their respective times, at the same *rate* of *Interest*.

3. In regard the said *Rule* doth mention no *particular Rate* of *Interest*, it ought to be true according to *any Rate* of *Interest*.

4. Let us therefore examine the said *rule* according to the *rate* of 6 *per centum, per annum, simple Interest*, taking the last mentioned question for *example*, which (according to the accustomed manner) will bee thus stated, *viz.* If 500 pound ought to bee paid in 5 yeares by equall payments (that is to say) 100 pound at each yeares end, what time ought to bee given for the payment of the said 500 l. at one intire payment, without losse either to the *Debitor* or *Creditor*?

5 Pro-

5. Proceeding according to the said *rule* of *Æquation* of *payments* (which saith, *As the summe or aggregate of the particular summes of money is to the sum or aggregate of the Products arising from the Multiplication of each particular sum of mony by its respective time, so is* 1 *or unity to the mean time to be assigned for one intire payment,*) there will bee found three yeares, which time (according to the said *rule*) ought to bee given for the payment of the whole 500 l.

6. The present worth of 500 pound due at the end of three yeares to come, *rebate* or *discompt* being made according to the *rate* of 6 *per centum, per annum, simple Interest* will be found (after the manner of the sixth question) to be 423 $\frac{42}{59}$ l. or 423 l, 14 s, 6 d, 3 farthings *proximè*; But (as is manifest by the resolution of the last mentioned question) the true present worth of 500 pound payable in 5 severall yeares, *rebate* being made according to the said *rate* of *Interest* is 425 $\frac{8286150}{8821267}$ l. or 425 l, 18 s, 9 $\frac{1}{2}$ d. *ferè*; and therefore the Creditor loseth 2 l, 4 s, 2 $\frac{3}{4}$ d. *proximè* in receiving the whole 500 pound, at three yeares end: Moreover at 6 *per centum, per annum, compound Interest*, he

hee would lose 1 l, 8 s, 6 d, *ferè*, as will bee manifest by the *Tables* of *compound Interest* hereafter expressed: So that the losse will bee either more or lesse; according as the *Rate* of *Interest* doth differ: And therefore I conclude the said *rule*; (As also whatsoever other *rules* or *resolutions* of Questions which have dependence thereon) to bee erroneous: But to returne to our purpose.

The fifth, sixth and seventh precedent Questions, may bee a foundation for the calculating of *Tables* of *Rebate* for any *rate* of *simple Interest*, and Time propounded, by which *Tables*, and by the help of *Multiplication*, questions concerning *Rebate* or *Discompt* of *money* according to *simple Interest* may be resolved without sensible error.

A Table

Years	*A Table for discompt of money for any number of years under 8. at 8 l. per centum, per annum, simple Interest.*	Years	*A Table for discompt of Annuities for any nūber of years under 8, at 8 l. per centum, per annum, simple Interest.*
1	.925925925	1	.925925925
2	.862068965	2	1.787994890
3	.806451612	3	2.594446502
4	.757575757	4	3.352022259
5	.714285714	5	4.066307973
6	.675675675	6	4.741983648
7	.641025641	7	5.383009289

The Numbers in the first *Table* on the left hand are *Decimalls*, one pound *Sterling* being the *Integer*, and are thus found, *viz.*

As 108--100--1--(.925925925,&c.
116--100--1--(.862068965,&c.
124--100--1--(.757575757,&c.

Whereby

Whereby it appears, that one pound due at the end of a yeare is worth in ready money .925925, &c. that is, 18 s, 6 d. *ferè*. Also one pound due at the end of two yeares is worth in ready money .862068, &c. that is, 17 s, 3 d. *ferè* (as will appeare by the nineteenth rule of the twelfth Chapter aforegoing) and so of the rest.

The use of the said *Table* will bee manifest by the following *example*:

Question 8. How much ready money will pay 345 l, 15 s, 6 d. due at the end of five yeares, *rebating simple Interest*, after the rate of 8 pound *per centum*, *per annum*?

Facit 246 l, 19 s, 7 $\frac{1}{2}$ d.

In the aforesaid *Table* for *Discompt* of *Money*, right against 5 yeares is the *Decimall* .714285, &c. being the ready money equivalent unto one pound due at the end of 5 yeares; Then (the 15 s, 6d. in the Question being reduced to a *Decimall* by the *Table* of *reduction* in page 87 of the preceding Booke) the proportion will be

1 —— .714285 —— 345.775
Facit 246.9818, &c.

That

That is, the *Decimall* being reduced according to the 19 rule of the 12 Chapter aforegoing 246 l, 19 s, 7 d. 2 f. *ferè*.

Upon the same ground numbers might be calculated for moneths or dayes.

The numbers in the second *Table* are found by the Addition of those in the first; *viz.* the first number in the latter *Table* is the same with the first in the former, the second in the latter is the summe of the first and second in the former; the third in the latter is the sum of the first, second, and third in the former, &c. (the reason of which operation will bee manifest by the seventh Question of this Chapter) whereby it appeares that one pound Annuity for two yeares is worth in ready money 1.787994, l. &c. *rebating* after the rate of 8 l. *per centum*, *per annum*, *simple Interest*: Also one pound Annuitie for seven yeares is worth in ready money 5 l, 383009, &c. and so of the rest.

The use of the said *Table* will be manifest by the following *Example*.

Question 9. How much present money is equivalent to an Annuitie of 50 l. per

per annum for five yeares, *discompting* after the rate of 8 l. *per centum, per annum, simple Interest*?

Facit 203 l, 6 s, 3 $\frac{3}{4}$ d.

In the second *Table* right against five yeares is 4.066307, &c. being the present worth of an Annuitie of one pound for five yeares, *discompting* after the *rate* of 8 pound *per centum, per annum*; Therefore it will be

If 1 — 4.066307 — 50
Facit 203.3153, &c.

That is, 203 l, 06 s, 03 d, 3 f. *fere*.

Of the forbearance of money at Compound Interest, or Interest upon Interest.

Question 10. If 425 pounds bee forborn or respited untill the end of foure yeares, what will it then bee augmented unto after the rate of 8 l. *per centum, per annum, compound Interest*?

Facit 578 l. .207808.

To resolve this and such like questions, there must bee found 4 numbers in continuall proportion increasing as 100 to 108, (or as 100 to 107 if the rate of Interest were

were 7 *per centum, per annum*, and the like of others *mutatis mutandis*) which may be performed according to the following operation.

l.	l.	l.	l.	*yeares*
100-	108-	425 ——	(459 at the end of-	1
100-	108-	459 ——	(495.72 ——	--2
100-	108-	495.72--	(535.3776 ——	3
100-	108-	535.3776	(578.207808 —	-4

Upon this ground there may bee calculated *Tables* of *forbearance* of one pound principall, at any rate of *Compound Interest*, and for any terme of yeares propounded, by which *Tables*, and by the help of *Multiplcation*, questions concerning the *forbearance* of *money* at *Compound Interest* may bee resolved without sensible error.

A Table

A Table shewing what 1 l. *will amount unto being forborn any number of yeares under* 31, *accounting compound Interest at* 8, 7, *and* 6, *per Centum, per Annum.*

Yeares	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
1	1.08	1.07	1.06
2	1.1664	1.1449	1.1236
3	1.25971	1.22504	1.19101
4	1.36048	1.31079	1.26247
5	1.46932	1.40255	1.33822
6	1.58687	1.50073	1.41851
7	1.71382	1.60578	1.50363
8	1.85093	1.71818	1.59384
9	1.99900	1.83845	1.68947
10	2.15892	1.96715	1.79084
11	2.33163	2.10485	1.89829
12	2.51817	2.25219	2.01219
13	2.71962	2.40984	2.13292
14	2.93719	2.57853	2.26090
15	3.17216	2.75903	2.39655

16

Ye.	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
16	3.42594	2.95216	2.54035
17	3.70001	3.15881	2.69277
18	3.99601	3.37993	2.85433
19	4.31570	3.61652	3.02559
20	4.66095	3.86968	3.20713
21	5.03383	4.14056	3.39956
22	5.43654	4.43040	3.60353
23	5.87146	4.74053	3.81975
24	6.34118	5.07236	4.04893
25	6.84847	5.42743	4.29187
26	7.39635	5.80735	4.54938
27	7.98806	6.21386	4.82234
28	8.62710	6.64883	5.11168
29	9.31727	7.11425	5.41838
30	10.06265	7.61225	5.74349

The Numbers in the first Columne on the left hand of the preceding *Table* signifie yeares: The numbers in the second Columne are calculated at the rate of 8 *per centum, per annum, compound Interest*, for 1 l. principall according to the following operation, *viz.*

As

As 100 is to-108 so is-1 to — -1.08
100 ——— 108 — 1.08 —— -1.1664
100 ——— -108 —— 1.1664-1.259712

The numbers in the third Columne are calculated at the rate of 7 *per centum per annum compound Interest* for one pound principall in the same manner as before, *viz.*

As 100 is to-107 so is-1 to —— -1.07
100 ——— -107- —— 1.07 — 1.1449
100 ——— -107- —— 1.1449- 1.225043

The numbers in the fourth Columne are calculated at the rate of 6 *per centum, per annum; compound Interest* for one pound principall, in the same manner as the former (*mutatis mutandis.*)

The use of the said Table will be manifest by the two following Questions.

Question 11. If 225 l. 10 s. be forborn untill the end of 9 yeares, what will it then amount unto after the rate of 8 *per centum per annum, Compound Interest?*

Facit 450 l. 14 s. 5 d. 3 f. *fere.*

In the second Columne right against 9 yeares

yeares is 1.999 which shewes that one pound being forborn 9 yeares, will bee augmented unto 1.999 at the rate of 8 *per centum, per annum, compound Interest;* therefore (the 10 s. in the question being reduced into a Decimall) it will be

If 1 ——— 1.999 ——— 225.5

Facit 450.7745 that is (the *Decimall* being reduced according to the nineteenth Rule of the twelfth Chapter) 450 l. 15 s. 5 d. 3 f.

Question 12. What will 136 l. 15 s. 6 d. amount unto, being forborn 20 yeares after the rate of 6 *per centum, per annum, compound Interest?*

Facit 438 l. 13 s. $1\frac{1}{4}$ d.

In the fourth Columne right against 20 yeares is 3.20713, which shewes that one pound being forborn 20 yeares will bee augmented unto 3.20713; therefore (the 15 s. 6 d. in the question being reduced into a *Decimall* by the *Table of Reduction,* in the 12 Chapter it will be

If 1 ——— 3.20713 ——— 136.775

Facit 438.655, &c. that is 438 l. 13 s. 1 d. 1 f. *fere.*

In the same manner, the numbers in the third

V third

third Columne, are to bee used.

Of the forbearance of Annuities, Rents or Pensions payable yearly, accounting Compound Interest.

Question 13. If an *annuitie* of 425 l. payable yearly be in Arrere for 4 yeares, unto what summe will it then amount accounting after the rate of 8 *per centum, per annum, compound interest*; for each particular *annuitie* from the time at which it grew due, untill the end of the said terme of 4 yeares?

Facit 1915 l. 1 s. 11. $\frac{1}{2}$d. *proximè.*

It is evident by the question, that if there be computed what 425 l. due at the years end will amount unto, being put forth at the said rate of *compound Interest* for the 3 following yeares; Also what 425 l. due at the second yeares end will be augmented unto in the two following yeares, and what 425 l. due at the third yeares end will bee augmented unto at the end of the following yeare; Lastly, if the said particular summes so found be added to 425 l. (the last yeares rent) the summe will be the totall rent in Arrere at the foure yeares end; *viz.*

According

According to the manner of the 10. question, 425 l. in 3 yeares after the rate of 8 li. *per cent. per ann. compound Interest* will be augmented unto	535.3776
In like manner, 425 li. in two yeares, will become	495.72
Also 525 li. at the years end, will become	459
The last yeares *Annuitie* is	425
The sum due at 4 years end	1915.0976

Otherwise,

Find a *principall* which may bee in the same proportion to 425 as 100 is to 8, and say

If 8 —— 100 —— 425 *Facit* 5312.5

Then find what 5312.5 will amount unto being forborn 4 yeares after the rate of 8 *per cent. per ann. compound Interest* (according to the 10. Question) which will be 7227.5976 from which subtracting the *principall* 5312.5 the remainder (as before) is 1915.0976 being the summe which 425 l. *annuity* will bee augmented unto at the end of 4 yeares, according to the

the ſaid rate of *Intereſt*, the *annuitie* being payable yearly.

Upon either of the aforeſaid grounds; *Tables* of the forbearance of one pound Annuitie at any rate of *compound Intereſt*, and for any terme of yeares, may bee calculated; or they may be compoſed by the addition of the numbers in the *Table* in page 288 *viz.* the firſt number in each of the Columnes in the ſubſequent *Table* is 1 or unity; the ſecond number in each (the Columne of yeares excepted) is compoſed of 1 or unitie, and the firſt number in the reſpective Columnes in the *Table* in page 288 Alſo the third number in each of theſe is compoſed of 1, and the ſumme of the 1 and 2 numbers in each of thoſe reſpectively, &c. But you are to obſerve that according to the laſt mentioned way of compoſition of the ſubſequent *Table*, the numbers in the *Table* in pag. 288 ought to be continued to more places then are there expreſt, to prevent error which may happen by reaſon of many Additions.

A Table ſhewing what 1 pound Annuity being forborn any number of yeares under 31 will amount unto at 8, 7, and 6, per Cent. per Ann. Compound Intereſt, the ſaid Annuitie growing due at yearly payment s

Yeares	8 per Cent.	7 per Cent.	6 per Cent.
1	1.00000	1.00000	1.00000
2	2.08000	2.07000	2.06000
3	3.24640	3.21490	3.18360
4	4.50611	4.43994	4.37461
5	5.86660	5.75073	5.63709
6	7.33592	7.15329	6.97531
7	8.92280	8.65402	8.39383
8	10.63662	10.25980	9.89746
9	12.48755	11.97798	11.49131
10	14.48656	13.81644	13.18079
11	16.64548	15.78359	14.97164
12	18.97712	17.88845	16.86994
13	21.49529	20.14064	18.88213
14	24.21492	22.55048	21.01506
15	27.15211	25.12902	23.27596

Ye.	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
16	30.32428	27.88805	25.67252
17	33.75022	30.84021	28.21287
18	37.45024	33.99903	30.90565
19	41.44626	37.37896	33.75999
20	45.76196	40.99549	36.78559
21	50.42292	44.86517	39.99272
22	55.45675	49.00573	43.39228
23	60.89329	53.43614	46.99582
24	66.76475	58.17667	50.81557
25	73.10593	63.24903	54.86451
26	79.95441	68.67646	59.15638
27	87.35076	74.48382	63.70576
28	95.33882	80.69769	68.52810
29	103.96595	87.34652	73.63979
30	113.28321	94.46078	79.05818

The use of the preceding *Table*, will be manifest by the following *Question*.

Question

Question 14. What will 20 l. *Annuitie* for 15 yeares payable yearly, be augmented unto being all unpaid or forborn untill the end of the said terme, accounting *Compound Interest* at the rate of 8 *per Cent. per Ann.* ?

Facit 543 l. 0 s. $10\frac{1}{4}$ d.

In the second Columne right against 15 yeares is 27.15211 which shewes that 1 pound *Annuitie* for 15 yeares, will at the end of the said terme accounting *compound Interest* after the rate of 8 *per cent. per ann.* amount unto 27.15211. therefore it will be

If 1 —— 27.15211 —— 20

Facit 543.0422 that is, 543 l. 0 s. $10\frac{1}{4}$ d.

In the same manner the numbers in the third and fourth Columnes are to be used.

Of Rebate or Discompt of money, according to Compound Interest.

Question 15. If 8 pounds bee due at the end of 5 yeares, what is it worth in ready money, *discompting* after the rate of 8 *per cent. per ann. compound Interest* ?

Facit $5\frac{6382465}{14348907}$ l.

To resolve this and such like questions, there must be found numbers in continuall proportion decreasing, as 108 is to 100, (or as 107 is to 100 if the rate were at 7 *per cent.*&c.) which may be performed according to the following operation, *viz.*

		l.
1	As 108 — 100 — 8 ——	$(7\frac{11}{27}$
2	108 — 100 — $7\frac{11}{27}$ —	$(6\frac{626}{729}$
3	108 — 100 — $6\frac{626}{729}$ —	$(6\frac{6902}{19683}$
4	108 — 100 — $6\frac{6902}{19683}$ —	$(5\frac{467795}{531441}$
5	108 — 100 — $5\frac{467795}{531441}$ —	$(5\frac{6382465}{14348907}$

Upon this ground, *Tables* of *Rebate* or *Discompt* may be calculated, according to *Compound Interest* for 1 pound *principall*, at any rate of *Interest*, and for any terme of yeares propounded, by which *Tables*, and by help of *Multiplication*, questions concerning *Discompt* or *Rebate* of *money* according to *compound Interest*, may be resolved without sensible error.

A Table.

A Table shewing what 1 l. *due at the end of any number of yeares to come under* 31, *is worth in ready money, discompting or rebating yearely after the rates of* 8, 7, *and* 6, *per Centum, per Annum, compound Interest.*

Years	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
1	.925925	.934579	.943396
2	.857338	.873438	.889996
3	.793832	.816297	.839619
4	.735029	.762895	.792093
5	.680583	.712986	.747258
6	.630169	.666342	.704960
7	.583490	.622749	.665057
8	.540268	.582009	.627412
9	.500248	.543933	.591898
10	.463193	.508349	.558394
11	.428882	.475092	.526787
12	.397113	.444012	.496989
13	.367697	.414964	.468839
14	.340461	.387817	.442300
15	.315241	.362446	.417265

16

Ye.	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
16	.291890	.338734	.393646
17	.270268	.316574	.371364
18	.250249	.295864	.350343
19	.231712	.276508	.330512
20	.214548	.258419	.311804
21	.198655	.241513	.294155
22	.183940	.225713	.277505
23	.170315	.210947	.261797
24	.157699	.197146	.246978
25	.146017	.184249	.232998
26	.135201	.172195	.219810
27	.125186	.160930	.207367
28	.115913	.150402	.195630
29	.107327	.140563	.184556
30	.099377	.131367	.174110

The numbers in the firſt Columne of the preceding *Table* ſignifie yeares; the numbers in the ſecond Columne are *Decimalls*, one pound being the *Integer*, and are calculated for the *rebate* or *diſcompt* of 1 pound *principall* after the rate

rate of 8 *per centum, per annnm, compound Intereſt* according to the following Operation, *viz.*

As 108-100-1-($\frac{25}{27}$ or .925925, &c.
As 108-100-$\frac{25}{27}$ or .925925, &c.($\frac{625}{729}$ or .857338, &c.

The *Decimalls* in the third and fourth Columnes are found in the ſame manner (*mutatis mutandis.*) The uſe of the preceding *Table* will be manifeſt by the following *example.*

Queſtion 16. If 356 pounds be payable at the end of ſeven yeares, what is it worth in ready money *diſcompting* after the rate of 7 *per centum, per annum, compound Intereſt?*

Facit 221 l. 14 s. *ferè.*

In the third Columne right againſt ſeven yeares is .622749 being the ready money equivalent unto 1 l. due at the end of ſeven yeares, *rebating* after the *rate* of 7 *per centum, per annum, Compound Intereſt*; therefore.

If 1 —— .622749 —— 356
Facit 221.6986, &c. or 221 l. 14 s. *proximè.*

In the ſame manner the numbers in the 2d. and 4th. Columnes are to be uſed.

Of

Of the preſent worth of Annuities, Rents, or Penſions, payable at yearly payments.

Queſtion 17. What is the preſent worth of an *Annuitie* of 8 pounds to continue 4 yeares, *diſcompting* after the *rate* of 8 *per centum, per annum, Compound Intereſt?*

Facit 26 $\frac{102330923441526}{205891132094649}$ lb.

It is evident by the *queſtion* that there muſt be computed (according to the manner of the 15th. *queſtion*) the preſent worth of 8 pound due at the firſt yeares end: Alſo the preſent worth of 8 pound due at the ſecond yeares end; and in like manner for the third and fourth yeares, which particular preſent values of each yeares *Annuitie* being added together, give the preſent value of the *Annuitie* propounded, *viz.*

8 Pounds payable at the end of one yeare, is worth in ready money (as will bee manifeſt by the 15th. *queſtion*:) ———— 7 l. $\frac{11}{27}$

8 Pounds

8 Pounds payable at the end of two yeares, is worth in ready money ———— 6 l. $\frac{626}{729}$

8 Pounds payable at 3 yeares end, is worth in preſent money ———— 6 $\frac{6902}{19683}$

8 Pounds payable at 4 yeares end, is worth in preſent money ———— 5 $\frac{467795}{531441}$

The preſent worth of 8 pounds *Annuitie* for 4 yeares ——— 26 $\frac{102330923441526}{205891132094649}$ l.

Upon this ground, *Tables* may be calculated to ſhew the preſent worth of 1 l. *Annuitie* for any terme of yeares, and at any *rate* of *compound Intereſt* propounded, or they may be compoſed more eaſily by the Addition of the numbers in the *Table*, in page 299 By which *Tables*, and by the help of *Multiplication*, queſtions concerning the preſent worth of *Annuities*, may be reſolved without ſenſible error.

A Table.

A Table shewing the present worth of 1 *pound Annuitie to continue any Terme of yeares under* 31, *and payable yearely, after the rate of* 8, 7, *and* 6, *per Centum, per Annum, Compound Interest.*

Yeares	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
1	.92592	.93457	.94339
2	1.78326	1.80801	1.83339
3	2.57709	2.62431	2.67301
4	3.31212	3.38721	3.46510
5	3.99271	4.10019	4.21236
6	4.62287	4.76653	4.91732
7	5.20637	5.38928	5.58238
8	5.74663	5.97129	6.20979
9	6.24688	6.51523	6.80169
10	6.71008	7.02358	7.36008
11	7.13896	7.49867	7.88687
12	7.53607	7.94268	8.38384
13	7.90377	8.35765	8.85268
14	8.24423	8.74546	9.29498
15	8.55947	9.10791	9.71224

Ye.	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
16	8.85136	9.44664	10.10589
17	9.12163	9.76322	10.47725
18	9.37188	10.05908	10.82760
19	9.60359	10.33559	11.15811
20	9.81814	10.59401	11.46992
21	10.01680	10.83552	11.76407
22	10.20074	11.06124	12.04158
23	10.37105	11.27218	12.30337
24	10.52875	11.46933	12.55035
25	10.67477	11.65358	12.78335
26	10.80997	11.82577	13.00316
27	10.93516	11.98671	13.21053
28	11.05107	12.13711	13.40616
29	11.15840	12.27767	13.59071
30	11.25778	12.40904	13.76482

The first number in the second, third, and fourth Columnes of the preceding *Table* is the same with the first in the second, third, and fourth Columnes respectively of the *Table* in page 299 the second in each of these is the summe

of

of the first and second in each of those respectively, the third in these is the summe of the first, second, and third in those respectively; But here you are to observe that according to the last mentioned way of composition of the preceding *Table*, the numbers in the *Table* in page 299 must be continued to more places then are there exprest, to avoid error which may happen by reason of many Additions.

The use of the preceding *Table* will be manifest by the subsequent *example*.

Question 18. What is the present worth of an *Annuitie* or *Rent* of 50 pounds *per annum*, payable yearly for 21 yeares, accounting *compound Interest* after the rate of 6 *per cent. per annum*?

Facit 588 l. 4 s. $\frac{3}{4}$ d. *fere*.

In the fourth Columne right against 21 yeares is 11 .76407 being the present value of one pound *Annuitie* for 21 yeares at the said rate of *compound Interest*, therefore

If 1 —— 11 .76407 —— 50

Facit 588 .2035 or 588 l. 4 s. $\frac{3}{4}$ d.

In the same manner the numbers in the second and third Columnes are to bee used.

Of

Of the purchase of Annuities, Rents or Pensions, (to continue any Terme of yeares, and at any rate of Compound Interest propounded.)

When a summe of money is propounded to finde what *Annuitie* (to continue any number of yeares, and according to any given rate) that summe will buy, presuppose at pleasure any *Annuitie* for the Terme propounded, and finde the value of that *Annuitie* in ready money (according to the manner of the seventeenth question) at the rate assigned; Then will the *proportion* be as followeth.

As the value found, is to the supposed Annuitie; so is the summe of money propounded, to the Annuitie required.

Question 19. What *Annuitie* to begin presently, and to continue 4 yeares, will 500 pounds deserve, accounting *compound Interest* at the rate of 8 *per centum, per annum*?

Facit 150 $\frac{6549343366545}{6819375447378}$ l.

Let the *suppositiall Annuitie* be 8 pound *per Annum*, to continue foure yeares, whose

X

whoſe value in ready money will be found (according to the manner of the 17th. *queſtion*) to be $26\frac{102330923441526}{205891132094649}$ l.

Then ſay,

If $26\frac{102330923441526}{205891132094649}$ l.— 8 l.— 500l.

Facit $150\frac{654934336654\overline{5}}{681937544737\overline{8}}$ l. or 150l. 19 s. 2 d. 2 f. *fere.*

Upon this ground, *Tables* may be calculated to ſhew what *Annuitie* (to continue any terme of yeares and at any rate propounded) one pound will buy, by which *Tables*, and by the help of *Multiplication*, *queſtions* concerning the *purchaſe* of *Annuities*, *Rents*, or *Penſions*, may bee reſolved without conſiderable error.

A Table ſhewing what Annuitie payable at yearely payments, to continue any terme of yeares under 31, one pound will purchaſe, at the rates of 8, 7, & 6, per Centum, per Annum, Compound Intereſt.

Yeares	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
1	1.08000	1.07000	1.06000
2	.56076	.55309	.54363
3	.38803	.38105	.37411
4	.30192	.29519	.28859
5	.25045	.24389	.23739
6	.21631	.20979	.20336
7	.19207	.18555	.17913
8	.17401	.16746	.16103
9	.16007	.15348	.14702
10	.14902	.14237	.13586
11	.14007	.13335	.12679
12	.13269	.12590	.11927
13	.12652	.11965	.10296
14	.12129	.11434	.10758
15	.11682	.10979	.10296

Ye.	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
16	.11298	.10585	.09895
17	.10962	.10242	.09544
18	.10670	.09941	.09235
19	.10412	.09675	.08962
20	.10184	.09439	.08718
21	.09983	.09228	.08500
22	.09803	.09040	.08304
23	.09642	.08871	.08127
24	.09497	.08718	.07967
25	.09367	.08581	.07822
26	.09250	.08456	.07690
27	.09144	.08342	.07569
28	.09048	.08239	.07459
29	.08961	.08144	.07357
30	.08882	.08058	.07264

The invention of the Numbers in the ſecond *Columne* of the preceding *Table*, is as followeth:

It

It is manifeſt by the tenth *queſtion*, and by the conſtruction of the *Table* in page 288, that one pound ready money is equivalent unto 1 $\frac{2}{25}$ l. or 1 .08 l. at the yeares end, at the rate of 8 *per centum, per annum*, which 1 .08 l. is the firſt number in the ſaid ſecond Columne: Again, the preſent value of one pound *Annuitie* for two yeares will bee found (according to the 17th. queſtion) to bee 1 $\frac{15417}{19683}$ l. or 1.78326474, &c. Therefore the proportion will be

If 1 $\frac{15417}{19683}$ l. or 1.78326474, &c. will purchaſe one pound *Annuitie* to continue two yeares, what *Annuitie* to continue the ſame terme will 1 pound ready money purchaſe? *Facit* $\frac{19683}{35100}$ l or .560769, &c. which is the ſecond number in the ſaid ſecond Columne of the preceding *Table*; from hence it is manifeſt that if unitie or 1 be divided by each number in the ſecond, third and fourth Columnes in the *Table* in page 304 the quotients will be the reſpective numbers of the ſecond, third and fourth Columnes in the preceding *Table*, in page 309, in which operation it will bee requiſite that the numbers of the ſaid *Table* in page 304, be continued to more places then are there expreſt.

 The

The use of the precedent *Table* in page 309 will be manifest by the following *example.*

Question 20. What *Annuity* to begin presently and to continue 14 yeares, payable at yearely payments will 320 l. purchase, *compound Interest*, being reckoned at 6 *per centum, per annum?*

Facit 34 l. 8 s. 6 d. *fere.*

In the fourth Columne right against 14 yeares is .10758 which shewes that one pound ready money will purchase an *Annuitie* of .10758 l. to continue 14 yeares; at the said rate of *compound Interest*, therefore it will be

If 1 —— .10758 —— 320
Facit 34.4256, &c. or 34 l. 8 s 6 d. *fere.*

Question 21. If 100 l. be put forth at *compound Interest* for two yeares, and at the end of the said terme bee augmented unto 116 $\frac{16}{25}$ l. what is the rate of *Interest*, or what was the said 100 l. augmented unto at the first yeares end?

Answer, The rate of *Interest* is 8 *per centum, per annum, viz.* the said 100 l. was augmented unto 108 l. at the years end.

In this question there are three numbers in *Geometricall proportion continued, viz.*

viz. 100 l. the principall; the summe unto which the said principall will be augmented at the yeares end, which is unknown: And the summe unto which it is augmented at the second yeares end, *viz.* 116 $\frac{16}{25}$, so that the scope of the question is to finde a *Geometricall mean-proportionall*, (or the middle number of the aforesaid 3 numbers) by knowing the two *extremes*, which is performed by this *Rule, viz.*

Two numbers being given to find a Geometricall mean proportionall.

Multiply the two extreme numbers one by the other, and extract the square-roote of the Product, which square-roote is the mean proportionall sought: So if the two *extremes* 100 and 116 $\frac{16}{25}$ bee multiplied together, the Product will bee 11664 whose *square-roote* is 108 for the *mean-proportionall* sought, which shewes that the principall 100 l. was augmented unto 108 l. at the yeares end, and therefore the rate of *Interest* is 8 *per centum, per annum.*

In the same manner you may finde the true *proportionall Interest* of 100 l. for $\frac{1}{2}$ yeare, according to the rate of 8 *per centum, per annum*, which ought not to be 4 l. (for he that receives 4 l. for 100 l. for $\frac{1}{2}$ yeare, may at the same rate of *Interest* put forth the said 4 l. for the following

lowing $\frac{1}{2}$ yeare, and ſo at the yeares end receive 108 l. 3 s. $2\frac{12}{25}$ d. which exceeds the rate of 8 *per centum*, *per annum*) but the ſumme which 100 l. will be augmented unto at the halfe yeares end is a *Geometricall mean-proportionall* between 100 and 108 which according to the former rule will bee found $\sqrt{10800}$ or 103.923048, &c. that is (the *Decimall* being reduced according to the 19th. *Rule* of the 12th. *Chapter*) 103 l. 18 s. $5\frac{3}{4}$ d. *proxime*.

The way to calculate Tables for half yearly payments.

Upon this ground, *Tables* for halfe yearely payments may be calculated at the rate of 8 *per centum*, *per annum*, *compound Intereſt*, in the ſame manner as thoſe in pa. 288, 295, 299, 304, 309. uſing the numbers 100, 103.923048, &c in ſtead of the numbers 100, 108. and the like may be done for any other rate of Intereſt (*mutatis mutandis*) which I leave to the practice of the Ingenious *Arithmetician*.

Queſtion 22. If 100 l. be put forth at *compound Intereſt* for 3 yeares, and at the end of the ſaid terme be augmented unto 125. 9712 l. what was it augmented unto at the firſt yeares end?

Facit 108 l.

Here obſerve, that the Principall 100 l. the

the ſummes unknown due at the ends of the firſt and ſecond yeares, and the ſumme unto which the Principall is augmented at the end of the third yeare, are foure numbers in *Geometricall proportion continued*, ſo that the tenour of the queſtion is to find the firſt of the two *mean-proportionalls* by knowing the two extremes, which is performed by this *rule*, *viz*.

To finde the firſt of two mean proportionalls between 2 extremes given.

Multiply the ſquare of the leſſer extreme by the greater, and extract the Cube roote of the Product, which Cube roote is the firſt of the two mean-proportionalls required: So if 100 l. (the leſſer extreme) be ſquared, it is 10000, which multiplied by 125.9712 (the greater extreme) produceth 1259712, whoſe *Cube roote* is 108 the firſt of the *mean-proportionalls* required, beeing the ſumme unto which the Principall will bee augmented at the yeares end.

Queſtion 23. What will 100 l. be augmented unto at the end of $\frac{1}{4}$ of a yeare after the rate of 8 *per centum*, *per annum*?

Facit 101 l. 18 s. 10 d. *proxime*.

In this queſtion there are 5 numbers in *Geometricall proportion continued*, *viz*. the Principall 100 l. the ſummes due at the end of the firſt, ſecond and third quarters

ters of the yeare, and 108 due at the yeares end, so that the tenour of the question is to find the first of *3 mean-proportionalls* between 100 and 108, which is performed by the following *rule, viz.*

To find the first of three mean proportionals between two extremes given.

Multiply the Cube of the lesser extreme by the greater, and extract the Biquadrate roote of the Product, which Biquadrate roote is the first of the three mean-proportionalls required : So if 100 bee multiplied Cubically, the Product is 1000000, which being multiplied by 108, the Product is 108000000, whose *Biquadrate roote* will be found (according to the 30th. *Rule* of the 18th. *Chapter*) 101.94265, &c. or 101 l. 18 s. 10 d. *proxime.*

Upon the aforesaid ground, *Tables* for quarterly payments may be calculated, at the rate of 8 *per centum per annum compound Interest* in the same manner as those in pages 288, 295, 299, 304, 309. using the numbers 100, 101.94265, &c. in stead of the numbers 100, 108, and the like may be done for any other rate of *Interest* (*mutatis mutandis.*)

Question 24. If the *Lease* of a house or lands be worth 153 l. *Fine*, and 16 l. *Rent per annum*, payable yearely for 21 yeares,

yeares, and the *Lessee* be desirous to bring down the *Fine* to 50 l. and, so to pay the more *Rent*, the question is what *rent* the Tenant shall pay, accompting *compound Interest* at the rate of 8 *per centum, per annum ?*

Facit 26 l. 5 s. $7\frac{3}{4}$ d.

Finde the difference between the *Fines* which is 103 l. Then by the *Table* in page 309 finde what *Annuitie* or *Rent* to continue 21 yeares, is equivalent unto 103 l. ready money, so will you find 10 l. 5 s. $7\frac{3}{4}$ d. which being added to the old rent 16 l. gives 26 l. 5 s. $7\frac{3}{4}$ d. which the *Tenant* must pay to the end that the *Fine* may be diminished unto 50 l.

Question 25. There is a *Lease* of certain Lands to be let for 14 yeares for 250 l. *Fine*, and 44 l. *Rent per annum*, payable yearely, but the *Tenant* is desirous to pay lesse *Rent, viz.* 20 pounds *per annum*, and to give a greater *Fine* ; The question is what *Fine* ought to be paid to bring down the *rent* to 20 l *per annum*, accompting *compound Interest* at the *rate* of 8 *per centum, per annum ?*

Facit 447 l. 17 s. $5\frac{1}{4}$ d.

Finde the difference between the *Rents* which will be 24 pounds *per annum*. Then by

by the *Table* in page 304, see what an *Annuitie* or *rent* of 24 l. *per annum*, to continue 14 yeares, is worth in ready money; so will you find 197 l. 17 s. 5 $\frac{1}{4}$ d. which being added to the first *Fine* 250 pounds, gives 447 l. 17 s. 5 $\frac{1}{4}$ d. which the *Tenant* must pay to the end the *rent* may be brought down to 20 l. *per annum*.

Question 26. There is a *Lease* of certain Lands worth 32 l. *per annum*, more then the *rent* paid to the Lord for it, of which Land there is a *Lease* yet in being for seven yeares, and the *Lessee* is desirous to take a *Lease* in *reversion* for 21 yeares, to begin when his old *Lease* is expired. the question is, what summe of money is to be paid for this *Lease* in *reversion*, accompting *compound Interest* at the *rate* of 6 *per centum*, *per annum*?

Facit 250 l. 7 s 2 d.

Find by the *Table* in page 304, what 32 l. *rent* is worth in ready money for 21 years as if it were to begin presently, which will be found 376.45024 l. Then by the *Table* in page 299, find what 376.45024 l. due at the end of 7 years to come is worth in ready money; so will it be 250 l. 7 s. 2 d. *proxime*, which is the *Answere* of the Question.

CHAP. IV.

CHAP. IV.

Containing a Geometricall Demonstration of the Rule of Alligation alternate, and the use of the said Rule in the composition of Medicines.

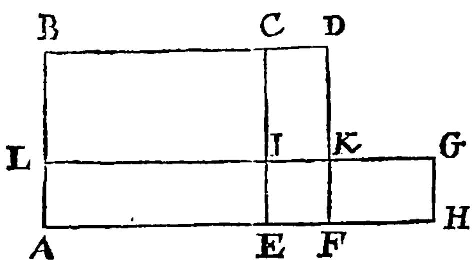
I. IF *three Numbers* A. B. C. *are given, in such sort that* A. *is lesse then* B. *but greater then* C. *then if the difference betweene* A. *and* B. *be multiplied by* C. *and the difference between* A. *and* C. *be multiplied by* B. *the summe of those Products will be equall to the Product arising from the Multiplication of* A. *by the summe of the said differences: So if* A. *be* 7. B. 10, *and* C. 5. *the difference betweene* A. *and* B. *will be* 3. which being multiplyed by C. produceth 15; Also the *difference* between A. & C. is 2, which being multiplied by B. produceth 20. Lastly, the

		diff.	*prod.*
A. 7.	B. 10	2	20
	C. 5	3	15
		5	35

the *summe* of the said *Products* is 35, which is equall to the *Product* of A. multiplied by the *summe* of the said *differences*, viz. the *Product* of 7 by 5.

II. *The like propertie will be in any three Numbers qualified as aforesaid, which is the thing required by the* Rule *of* Alligation *alternate in the commixture of two things miscible, and may be demonstrated as followeth.*

Construction.



Vide P. Herigone, Tom. 2.

Let B and C be forementioned (which you may suppose to be the *prices* of two things given to bee mixt) be represented by the right lines. — A H & A E

Let

Let A (the *mean price* assigned for the mixture) be —— A F.

Then will the *difference* between A F (the mean price) and A H. (the greater of the two prices miscible) be —— F H.

Also the *difference* between A F (the meane price) and A E (the lesser of the two prices miscible) will be —— E F.

Then will the *summe* of the said *differences* be —— E H.

Make A L equall to E F, and perpendicular to A H, and with the lines A H, A L, describe the *Parrallelogram* A L G H, *viz.* —— ▭ A G.

Make A B equall to E H, and perpendicular to A H, and describe the *Parallelogram* A B D F, *viz.* —— ▭ A D.

Also describe the *Parallelogram* A B C E, *viz.* —— ▭ A C.

The

The Proposition to be Demonstrated.

▭ A G. ✢ ▭ LC. ═ ▭ A D.

That is to say, the *Parallelogram* ALGH (or the *Product* arising from the *Multiplication* of the greater of the two prices miscible, by the *difference* between the *mean price* and the *lesser price*) together with the *Parallelogram* LBCI, (or the *Product* arising from the *Multiplication* of the *lesser* of the two *prices* miscible, by the *difference* between the *mean price* and the *greater price*) are equall to the *Parallelogram* ABDF (or the *Product* of the *mean price* multiplied into the *summe* of the said *differences*.)

Demonstration.

═ signifies *Equall to*.

: : signifies the middle of 4 proportionalls.

✢ signifies *plus* or more, and is the signe of *Addition*.

— signifies *minus* or lesse, and is the signe of *Subtraction*.

By *Construction* > EF or IK ═ LA or KF

Also by *Construction*. } FH or KG ═ LB or KD

Wherefore by 7 è 5 *Euclid. Elem.* } KG . IK : : KD . KF

And by 14 è 6 > ▭ FG ═ ▭ ID

Therefore (w^ch^ was to be demonstrated.) } ▭ AG ✢ ▭ LC ═ ▭ AD

Coro-

Corollary.

Hence it is manifest, that if the *summe* of the *Products*, arising from the Multiplication of the *prices* (or *qualities*) of two things miscible, by the respective *Alternate differences* between the *mean price* and the said two *prices* miscible, be divided by the *summe* of the said *differences*, the *Quotient* will be the *mean price*, and such is the *Proofe* of the *Rule* of *Alligation alternate*.

When more then two prices are given to be mixed, the *Demonstration* will not be otherwise, for if the *summe* of every two *Products* arising from the Multiplication of two *alternate differences* into their respective *prices*, be equall to the *Product* of the *mean price* and the *summe* of the said *differences*, the *summe of all the said products* will also be equall to the *product* of the *mean price*, and the *summe* of all the *differences*.

Of the Composition of Medicines.

See Mr. *J.* Dee his Mathem. Preface also *P. Herigone Tom* 2. and Mr. *Mores*, Arithmetique.

I. *Medicines* and *Simples* in respect of their *qualities* are considered in some of these 5 wayes, *viz.* either as they are *hot* or *cold*, *moyst* or *drie*, or as they are *temperate*

Y

perate; so that such *Simples* or *Medicines* which work *heat* in our bodies are said to be hot, such cold which are the cause of coldnesse, &c.

II. The *mean* or *middle* between the *extreme qualities* of *Heat* and *Coldnesse*; also between *Drinesse* and *Moysture*, is called *Temperate* or the *Temperature*; from which each of the said qualities *hot*, *cold*, *moyst*, *dry*, doth differ in 4 *degrees*, so that a *Medicine* or *Simple* is said to bee either *temperate*, or else *hot*, *cold*, *moyst*, or *dry*, in the first, second, third or fourth *degree*.

III. If the numbers 1,2,3,4,5,6,7,8,9 be placed as you see from A to B, the *differences* between 5 (the middle number) and the Superiour numbers 6,7,8,9. will be 1,2,3,4. which may represent the 4 *degrees* of the *qualities hot* and *dry*, likewise the *differences* between 5 and the inferiour numbers

	Ind.	degr.	
B	9	4	*Qualities hot and drie.*
	8	3	
	7	2	
	6	1	
	5	0	*Temperature.*
	4	1	*Qualities cold and moyst.*
	3	2	
	2	3	
A	1	4	
	Ind.	degr.	

numbers 4,3,2,1. will be 1,2,3,4. which may represent the 4 *degrees* of the *qualities cold* and *moist*, the *temperature* represented by 0, being the *mean* or *middle* from whence the said *degrees* doe proceed.

IV. Since the *Rule* of *Alligation alternate* requires, that of two things miscible, the one must *exceed* the *mean* propounded and the other be *lesse*; therefore the questions of *Alligation* in this kinde are to be wrought with the numbers in the aforesaid *Columne* A B, for by them, the *degrees* and *qualities* are discovered, being placed as you see in the *Columne* adjacent to A B, and for distinction sake, those numbers in the said *Columne* A B, may be called the *Indices* or *Exponents* of the *degrees*, which *Indices* are to bee used in the same manner as the *prices* of Merchandizes in the questions of *Alligation alternate* in Chap. 27. of the preceding Book; and therefore those *examples* may bee compared with these.

Prop. I.

Having divers Simples whose qualities are known, to make a composition or mixture

ture of them, in such manner that the quality of the Medicine may be some mean amongst the qualities of the Simples, and the quantity thereof any quantity assigned.

Exam. 1. An *Apothecary* hath foure sorts of *Simples*, A, B, C, D, whose *qualities* are as followeth *viz.* A is *hot* in the fourth *degree*, B is *hot* in the second, C is *temperate*, and D is *cold* in the third *degree*; the question is to know what quantities of each ought to be taken, to make a *Medicine*, whose quantity may bee 12 *Ounces*, and the quality in the first *Degree* of *heat?* Seek in the aforesaid *columne* A B, for the *Indices* or *exponents* of the qualities of the *Simples* given, *viz.* for A which is *hot* in the fourth *Degree*, take 9; for B which is *hot* in the second, take 7; for C which is *temperate*, take 5; and for D which is *cold* in the third *degree*, take 2; that done, rank those numbers in the same manner as the *prices* of Merchandizes in the questions of the 27. Chapter, *viz.* descend from the highest *degree of heat* unto the *temperature*, and so proceed downwards to the *degrees* of *cold*, setting the *Index* or *exponent* of the *mean quality* propounded, as common to them all: Then by crooked lines or otherwise, connect

nect two such *Indices* whereof one may be greater then the *mean* & the other lesse, and proceeding according to the *Rules* of the 27 *Chapter*

	Degr.	*Oun.*		*The proof.*	
	9	1	A	9...1	9
6	7	4	B	7...4	28
	5	3	C	5...3	15
	2	1	D	2...1	2
		9			9)54(6

you will find that to make a *Medicine* of 9 *Ounces*, and the *quality* resulting to be in the first *degree* of *heat*, you must take 1 *Ounce* of A (being that *Simple* which was *hot* in 4°.) 4 *Ounces* of B, 3 *Ounces* C, and 1 *Ounce* of D, as will be manifest by the proofe: Lastly, by the *Rule* of *Proportion* you may increase the *Medicine* to the quantitie of 12 *Ounces*, and yet the *qualitie* to continue in the first *degree* of *heat*, according to the following operation.

Oun.

9 — 1 — 12 (*Facit* $1\frac{1}{3}$ of A.

9 — 4 — 12 (*Facit* $5\frac{1}{3}$ of B.

9 — 3 — 12 (*Facit* 4 of C.

9 — 1 — 12 (*Facit* $1\frac{1}{3}$ of *D.*

The quantitie assigned 12 *Ounces.*

By other *connexions* of the *qualities*, other quantities of each *Simple* would arise but that hath been sufficiently manifested in the questions of the 27 *Chapter.*

Exam. 2. Suppose there are five *Simples*, A, B, C, D, E, whose *qualities* are as followeth, *viz.* A is *hot* in 3°. B is *hot* in 2°. C is *hot* in 1°. D is *cold* in 1°. and E is *cold* in 3°. and it is required to mix 4 *Ounces* of B, with such quantities of the rest, that the *quality* of the *Medicine* may be *Temperate* ?

Proceed as before, so will you find that to make a *medicine* of 11 *Ounces*, and the *qualitie* of the *Form* resulting to be *Temperate*, you must take 1 *Ounce* of A, 3 *Ounces* of B 1 *Oun.* of C, 4 *Ounces* of D and 2 *Ounces* of E; Then since the quantitie of B in the composition propounded is limited; *viz.* 4 *Ounces*, Finde numbers which may be in such proportion to 4 (the quantitie of

Degr.		*Oun.*		*the pr.*	
8	1	1	A	8-1	8
7	3	3	B	7-3	21
5 6	1	1	C	6-1	6
4	3,1	4	D	4-4	16
2	2	2	E	2-2	4
		11		11)55(5	

of B assigned) as the numbers 1, 1, 4, 2 (the quantities of A, C, D, E, in the aforesaid *Composition* of 11 *Ounces*) are unto 3. (the quantitie of B in the said *Composition*) in manner following:

	Ounces	
3—1—4	(*Facit* $1\frac{1}{3}$ of A.	to be mixed with foure *Ounces* of B.
3—1—4	(*Facit* $1\frac{1}{3}$ of C.	
3—4—4	(*Facit* $5\frac{1}{3}$ of D	
3—2—4	(*Facit* $2\frac{2}{3}$ of E.	

Prop. 2.

A *medicine* being compounded of divers *Simples* whose *qualities* and *quantities* are known, to finde the *degree* of the *Form resulting*, viz. the exact *Temperament* of the *medicine*.

Examp. 1. Suppose a *medicine* to be compounded of two *Simples*, viz. 6 *Ounces* of B *hot* in 4°. and 3 *Ounces* of C *hot* in 3°. and it is required to find the *temperament* of the *medicine*, viz. the *degree* and *quality* resulting from such mixture? Seeke in the aforesaid *Columne* A B for the *Indices* of the respective *degrees* and *qualities*

qualities of the *Simples* given, and dispose them orderly in rankes right against their respective *quantities*, then multiply each *Index* into its respective *quantity* and divide the *summe* of the *products* by the *Summe* of the *quantities*, so will the *Quotient* bee the *Index* of the *degree* and *qualitie* of the *Medicine*: So in the said example, the Quotient will be found 8 $\frac{2}{3}$ which is the *Index* of 3 $\frac{2}{3}$ *degrees of heat*, and therefore the said *medicine* is *hot* in 3 $\frac{2}{3}$ degrees.

Degr. Oun.
9..6 | 54
8..3 | 24
9) 78 (8 $\frac{2}{3}$

Forasmuch as any two quantities miscible according to the *Rule* of *Alligation alternate*, are in such proportion one to the other, as the respective *alternate differences* between the *mean quality* of the mixture and the *qualities correspondent* unto the said quantities, the demonstration of the aforesaid *rule* will be manifest by the *Corollary* in page 323.

Examp. 2. Suppose a *medicine* to be compounded of 4 *Simples*, whose qualities and quantities are known, *viz.* 2 *Ounces* of

of A *hot* in 3°. 3 *ounces* of B *hot* in 2°. 4 *ounces* of C *temperate*, and 5 *ounces* of D *cold* in 4°. and let it be required to finde the mean quality resulting from such mixture? Finde the quality resulting from the commixture of any two of the *Simples* given (according to the operation in the last example) then proceed in like manner with the *quality resulting*, and some other of the *Simples* given; So after due repetition of the same worke with every one of the *Simples*, the last operation will shew the *Index* of the *degree* and *qualitie* resulting from the commixture of them all; Or which is the same in effect and more brief, *multiply each Index by its respective quantity, and divide the summe of the products*

Deg.oun.Prod.
8..2 | 16
7..3 | 21
5) 37 (7 $\frac{2}{5}$

7 $\frac{2}{5}$..5 37
5...4 20
9) 57 (6 $\frac{1}{3}$

6 $\frac{1}{3}$..9 | 57
1...5 | 5
14) 62 (4 $\frac{3}{7}$

De.oun.Prod.
8...2 | 16
7...3 | 21
5..4 | 20
1...5 | 5
14) 62 (4 $\frac{2}{7}$

ducts by the ſumme of the quantities, ſo will the quotient be the Index of the degree and quality of the medicine; By either of which wayes you will finde $4\frac{3}{7}$ which is the *Index* of $\frac{4}{7}$ *degrees* of *heat* (for the difference between 5 the *Index* of the *temperature*, and $4\frac{3}{7}$ the *Index* found, is $\frac{4}{7}$ *degrees* of *heat*) which is the qualitie of the ſaid *medicine*.

Examp. 3. Suppoſe a *medicine* to be compounded of ſeverall *Simples*, whoſe *qualities* and *quantities* are as followeth, *viz.* 4 *Ounces* of a *Simple* which is *cold* in 2°. and *moiſt* in 1°. 5 *ounces hot* in 3°. and (in reſpect of *drineſſe* and *moiſture*) *temperate*; 3 *ounces hot* in 2°. and *dry* in 2°. 6 *ounces hot* in 1°. and *moiſt* in 4°. 4 *ounces cold* in 3°. and *moiſt* in 2°. the queſtion is to know the *Temper reſulting?*

In the reſolution of this queſtion there muſt be two diſtinct operations, each of them like to that in the laſt *Example*; *viz.*

1. Find in the ſame manner as before, the *degree* and *quality reſulting* from the commixture of the *qualities hot* and *cold*, ſo will you find $5\frac{7}{22}$ which is the *Index* of $\frac{7}{22}$ *degree* of *heat* (for the difference between 5 the *Index* of the *Temperature* and $5\frac{7}{22}$ the *Index* found, is $\frac{7}{22}$ *degrees* of *heat*.

Deg.	*oun.*	*prod.*	*Deg.*	*oun.*	*prod.*
8	5	40	4	4	16
7	3	21	5	5	25
6	6	36	7	3	21
3	4	12	1	6	6
2	4	8	3	4	12
	22)117(	$5\frac{7}{22}$		22)80(	$3\frac{7}{11}$

2. Find in the ſame manner, the *Temper reſulting* from the mixture of the *qualities dry* and *moiſt*; ſo will you find $3\frac{7}{11}$ which is the *Index* of $1\frac{4}{11}$ *degrees* of *moiſture*; ſo the *qualitie* of the ſaid *medicine* is $\frac{7}{22}$ *degrees* of *heat* and $1\frac{4}{11}$ *degrees* of *moiſture*, as by the operation is manifeſt.

Prop. 3.

To augment or diminiſh a medicine in qualitie according to any degree aſſigned.

Suppoſe a *medicine* to be compounded as followeth, *viz.* 1 *dram* of a *Simple dry* in 4°. 2 *drams dry* in 3°. 2 *drams dry* in

in 2°. 1 *dram dry* in 1°. 1 *dram cold* in 1°. and 1 *dram cold* in 2°. So will the *quality* of the ſaid *medicine* be in $1\frac{1}{2}$ *degrees* of *heat*, (as will be manifeſt by the ſecond *Propoſition.*) Now let it bee required to augment the ſaid *medicine* in *quality*, viz. to adde ſuch a quantity of ſome one of the *Ingredients*, (or of ſome other *ſimple*) which may raiſe the *quality* of the *medicine* $\frac{1}{2}$ *degree*; ſo that the *Temperament* of the *medicine* after it is increaſed in quantity, may be in 2°. of *heat*. Make choice of ſuch a *ſimple*, the *Index* of whoſe *quality* may exceed (or at leaſt bee equall unto) the *Index* of the *quality* aſſigned, *viz.* make choice of that *ſimple* which is *hot* in 3°. whoſe *Index* is 8, then proceed according to the 1 *Example* of the firſt *Propoſition*; So will you finde that if 1 *dram* of the aforeſaid *medicine* be mixed with $\frac{1}{2}$ *dram* of that *ſimple* which is *hot* in 3°. the *Temper reſulting* from ſuch mixture will bee in 2°. of *heat*.

Laſtly, by the *Rule* of *Three*, ſay, if 1 *dramme* require $\frac{1}{2}$ *dramme*, what ſhall 8 *drammes* (the quantitie of the *medicine* firſt given) require?

Facit

Facit 4 *drammes*: So that if 4 *drams* of a *Simple* which is *hot* in 3°. bee mixed with 8 *drammes* of a *medicine* which is *hot* in $1\frac{1}{2}$ *degree*, the *Temper reſulting* will be in 2°. of *heat*, as by the Operation in the *Margent* is manifeſt.

Deg. Drams

$$7\left\{\begin{array}{l|l} 6\frac{1}{2} & 1 \\ 8 & \frac{1}{2} \end{array}\right.$$

If 1 — $\frac{1}{2}$ — 8 (*Facit* 4 *drams*

The proofe,

Deg.	*Drams*	
$6\frac{1}{2}$..	8	52
8...	4	32
	12)	84 (7

If it be required to *diminiſh* a *medicine* in *quality*, you are to make choice of ſuch a *Simple* the *Index* of whoſe *quality* may be leſſe then the *Index* of the *qualitie* aſſigned, and then to proceed as before.

Here obſerve, that if in queſtions of this nature, the quantities of the *Simples* be expreſt by *waights* of *divers denominations*, they are to be reduced to that *waight* which is of the *loweſt denomination* in the *queſtion*, according to the *Rules* of

of the 6 Chapter and by help of the subsequent *Table*.

Apothecaries waights.

℔. *A pound,*	*is equall unto*	12 *Ounces.*
℥ *An Ounce,*		8 *Drams.*
ʒ *A Dram,*		3 *Scruples.*
℈ *A Scruple,*		20 *Grains.*

The augmenting or diminishing of a *medicine* in respect of *quantity*; Also the finding of the *value* of any *quantitie* of a *medicine*, the *prices* of the *Ingredients* being known, will bee familiar to such as understand the *Rule* of *Proportion*, and therefore I shall not insist upon them.

CHAP.

CHAP. V.

Containing a Geometricall demonstration of the Rule of False, by two Positions.

After due processe is made according to the conditions in the questions and the *Errors* of both *Positions* are discovered as is directed in the 5th. Rule of the 28th. Chapter, the number sought may bee found according to the following Rules, viz.

When the Signes of the Errors are unlike.

Rule I. *As the summe of the errors is to the first error, so is the difference of the supposed numbers to a fourth proportionall, which being added to the first supposed number, when the said first Supposition is lesse then the second, or subtracted from it when it exceeds the second, the summe or remainder will bee the true Number sought.*

When

When the Signes of the Errors are alike.

Rule II. *As the difference of the errors is to the first error, so is the difference of the supposed numbers to a fourth proportionall, which being added to the first supposed number, when the Signes are — or subtracted from it when the Signes are +, the summe or remainder will bee the number sought.*

Example: Let it be required to divide 100l. amongst three persons *A*, *B*, *C*, in such sort that the share of *B*, may be the triple of the share of *A*, and foure pound over and above; Also that the share of *C*, may bee equall to the summe of the shares of *A*, and *B*; and 6 pound more. *Facit* *A*, $10\frac{3}{4}$ l. | *B*, $36\frac{3}{4}$ l. | *C*, 53 l. which three numbers added together, make 100 pound, and doe answer the conditions in the Question.

The first Rule *afore mentioned will be exercised in the two following varieties.*

Let the first *position* for the share of *A*, be

be 12, and the second *position* 8, then will the *errors* be found + 10 and — 22, and according to the first *Rule* the share of *A* will be found $10\frac{3}{4}$, and consequently the share of *B*, $36\frac{3}{4}$. and the share of *C*, 53.

Posit. *Errors.*

12 + 10

8 — 22

4   32... 10.. 4 ($1\frac{1}{4}$

12

$10\frac{3}{4}$ for *A.*

Again, let the first *position* for the share of *A* be 9, and the second *position* 11, then will the *errors* be found — 14, and + 2, and according to the said first Rule, the share of *A* will be found as before $10\frac{3}{4}$.

Posit. *Errors.*

9 — 14

11 + 2

2   16... 14... 2 ($1\frac{3}{4}$

9

$10\frac{3}{4}$ for *A.*

The second Rule will be exercised in the two following varieties.

Let the *Supposititious* Numbers for the share of *A* be 8 and 9, then will the *errors* be found —22, and — 14, and according to the said second *Rule*, the share of *A* will be found as before $10\frac{3}{4}$.

Posit. *Errors.*

$$\begin{array}{ll} 8 - 22 & \\ \underline{9 - 14} & \\ 1 \quad 8 \ldots 22 \ldots 1 & (2\frac{3}{4} \\ & \underline{8} \\ & 10\frac{3}{4} \text{ for } A. \end{array}$$

Again, let the *suppositions* for *A* be 14 and 11, then will the *errors* be found + 26 and + 2 and according to the said second Rule, the share of A will be found $10\frac{3}{4}$ as before.

Posit. *Errors.*

$$\begin{array}{ll} 14 + 26 & \\ \underline{11 + 2} & 14 \\ 3 \quad 24 \ldots 26 \ldots 3 & (3\frac{1}{4} \\ & 10\frac{3}{4} \text{ for A.} \end{array}$$

The

The *Rule* of *False* hath been much inlarged by *Gemma Phrisius*, *Simon Iacob*, *Ed. Leon* and others, who make the same capable of resolving questions which were formerly esteemed not resolvable without the Rule of *Algebra*, but in regard they have not given sufficient light (as I conceive) how to discover unto which of those *Rules* by them delivered, a question doth belong, there cannot arise any frugall use from their additionall Rules of *Squaring*, *Cubing*, &c. of the *positions*; wherefore the common *Rule* of *False* by *two positions*, as it is held forth in this Chapter, and in the 28 Chapter of the preceding Book (agreeable to the sense of most Authors) is (as I suppose) the most usefull, which alwaies requires that there may be the same *reason* between the *errors* as is between the *differences* of the number sought, and the *supposititious* numbers, which will be onely in such questions where the number sought, and each supposed number is either increased, lessened, multiplied or divided by some common number, or contrarily when some common number is increased, lessened, &c. by the number sought and each supposed number; for in such Case, when the conditions of the question onely

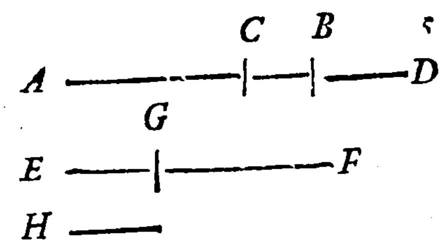
To discern what questions are resolvable by the ordinary Rule of False by two positions.

 require

require *Addition* and *Subtraction*, there will be equall *reason* between the *errors*, and the *differences* of each supposed number and the number sought: So if 3 be added to each of the numbers 5,7,12,(which may represent the number sought, and the supposititious numbers) the summes will be 8, 10, 15, whose *differences* will bee equall to the *differences* of the former respectively; In like manner if 3 bee subtracted from each of the said numbers, 5,7,12. the remainders will bee 2,4,9. whose *differences*, are the same with the former respectively: Moreover, when the conditions of the question require *Multiplication* or *Division*, the number sought, and the supposed numbers being multiplyed or divided by some common number, will produce three numbers in the same proportion with the former, and therefore the *differences* of the latter will be in the same proportion with the *differences* of the former respectively, (by 19 è 5 *Euclid, Elem.*) whereby it is manifest, that the *errors* in the *Rule of False* between two *positions* (being the *differences* between the number resulting from the number sought, and the two numbers resulting from the *supposititious* numbers by the ope-

operation of some common number) are in such proportion as the *differences* between the number sought and the two *supposed* numbers; which being granted, the first of the two *Rules* mentioned in *page* 337 may bee Demonstrated in manner following.

Preparation.



1	Let the thing required be	*A B*
2	Let the first *Hypothesis* (given) be	*A C*
3	Let the second *Hypothesis* (also given) be	*A D*
4	Then it is manifest that the *differences* between the thing required, and the *suppositions* are	*C B*, *B D*

Z 3 Also

5 Alſo it is manifeſt that the *difference* between the *ſuppoſitions* (which is given) is ——— CD

6 Let the *error* of the firſt *Hypotheſis* (which is given) be ——— EG

7 Let the *error* of the ſecond *Hypotheſis* (likewiſe given) be ——— GF

8 Then according to the property of the *rule* of *Falſe* before defined, this proportion will ariſe. *viz.* $EG.GF :: CB.BD$

9 And according to *Rule* I. in page 337 in regard the *Signes* of the *errors* are unlike, it will be ——— $EF.EG :: CD.H$

10 Which fourth proportionall H according to the ſaid *Rule I.* (in regard the firſt *ſuppoſition* is leſſe then the ſecond) being added to the firſt *ſuppoſition* AC muſt give the thing ſought, *viz.* $AC + H = AB$

The

The Propoſition to be Demonſtrated;

$$AC + H = AB$$

Demonſtration.

By the aforeſaid preparation, *viz.* by the 8th. in order it is manifeſt that ——— $CB.BD :: EG.GF$

Wherefore by the 18 è 5 *Euclid. Elem.* ——— $CD.CB :: EF.EG$

And by the 9th. in order it is manifeſt that ——— $CD.H :: EF.EG$

Wherefore by 11 è 5 *Euclid. Elem.* ——— $CD.CB :: CD.H$

And by 9 è 5 *Euclid. Elem.* ——— $H = CB$

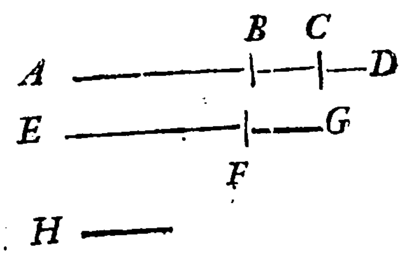
Therefore (which was to be demonſtrated.) ——— $AC + H = AB$

Upon the ſame grounds, the *demonſtration* of the latter part of the ſaid *Rule* I. (*viz.* when the firſt *Suppoſition* exceeds the ſecond) will bee obvious; and therefore I ſhall omit it.

 When

When the Signes of the Errors are alike.

Preparation.



1 Let the thing required be — AB

2 Let the first *Hypothesis* (given) be — AC

3 Let the second *Hypothesis* (also given) be — AD

4 Then it is manifest that the *differences* between the thing sought and the Suppositions are — BC, BD

5 Also it is manifest that the *difference* between the *Suppositions* is — CD

6 Let

6 Let the *error* of the first *Supposition* (which is given) be — EF

7 Let the *error* of the second *Supposition* (which is likewise given) be — EG

8 Then according to the property of the *Rule of False* before defined, this proportion will arise, *viz.* — EF . EG :: BC . BD

9 And according to *Rule* II. in page 338 in regard the *errors* are alike it will be — FG . EF :: CD . H

10 Which fourth proportionall H, according to the said *Rule* II. (in regard the *Signes* are both +) being subtracted from AC (the first *Hypothesis*) must leave the thing sought, *viz.* — $AC - H = AB$

The

The Proposition to be Demonstrated.

$$AC - H = AB$$

Demonstration.

By the eighth in order, it is manifest that ———	BC. BD : : EF. EG
Therefore by 17 è 5 *Eucl. elem.* ———	CD. BC : : FG. EF
By the ninth in order, it is manifest that ———	CD. H : : FG. EF
Wherefore by 11 è 5 *Euclid. elem.* ———	CD. BC : : CD. H
Wherefore by 9 è 5 *Euclid. elem.*	H = BC
Therefore (which was to bee Demonstrated.)	AC — H = AB

CHAP.

CHAP. VI.

Containing 34 pleasant and subtile Questions, which will exercise all the parts of Naturall Arithmetique.

Question 1. IF a *wedge* of *Gold* waighing 17 $\frac{3}{7}$ lb. *Troy*, bee worth 679 $\frac{5}{7}$ lb. *sterling*, what is the value of 1 $\frac{3}{13}$ *grain* of that *Gold*? Examples of the Rule of Three direct.

Facit 2 d.

If $\frac{122}{7}$ lb. ——— $\frac{4758}{7}$ l. ——— $\frac{1}{4680}$ lb.

Facit 2 d.

Question 2. A *man* dying gave to his *eldest sonne* $\frac{2}{3}$ of $\frac{1}{4}$ of his *estate*, to his *second sonne* $\frac{1}{5}$ of $\frac{1}{2}$ of his *estate*, and when they counted their *portions*, the one had 40 lb. more then the other, the remainder of the *estate* was given to the *wife* and *younger children*, the question is, what was the *portion* of the *eldest sonne*, also of the *second*, and how much did belong to the *wife* and *younger children*?

Facit the *eldest sons portion* 100 lb.

the

the *second sons portion* 460 ℔. and 440 ℔. for the *wife* and *younger children.*

The Fractions being reduced, it will be manifest that the eldest sonne had $\frac{1}{6}$, *and the second* $\frac{1}{10}$, *also the difference of the said Fractions is* $\frac{1}{15}$, *then say,*

I. If $\frac{1}{15}$ —— $\frac{40}{1}$ —— $\frac{1}{10}$

Facit 60 ℔. *the second sonnes portion:*
adde 40 *the difference of their portions*

Facit 100 *the eldest sonnes portion.*

II. If $\frac{1}{15}$ —— $\frac{40}{1}$ —— $\frac{1}{1}$

℔.

Facit 600 *the whole estate;*
subtract 160 *the sum of both the sons port.*
remains 440 *for the wife and younger children.*

Question 3. A *young man* received $66\frac{2}{3}$ ℔. which was $\frac{2}{3}$ of $\frac{1}{2}$ of his *elder brothers portion* and $3\frac{1}{2}$ times of his *elder brothers portion* was $1\frac{1}{4}$ times of his *fathers estate*, the *question* is, what was the *fathers estate?*

Facit 560 ℔.

I. If

I. If $\frac{1}{3}$ —— $66\frac{2}{3}$ —— 1

℔.

Facit 200 *the elder brothers portion*
$3\frac{1}{2}$

700 *equall to* $1\frac{1}{4}$ *of the whole estate.*

II. If $1\frac{1}{4}$ —— 700 —— 1

Facit 560 *the whole estate.*

Question 4. There is a *cistern* supplied with water by three *pipes*, whose *cocks* are *A*, *B*, *C*; by *A* set open alone, the *cistern* will be filled in $2\frac{5}{9}$ *houres*, by *B* in $1\frac{2}{7}$ *houre*, by *C* in $\frac{5}{8}$ *houre*; the question is, to know in what time the *cistern* will be filled when all the three *cocks* are set open at once?

Facit $\frac{230}{619}$ *houre* or 22 : 17 : 38 $\frac{298}{619}$.

Find how much of the cistern will bee filled by each pipe in one and the same time, then it will bee, as the said cisterns or parts so found, to the correspondent time; so is 1 *or the whole cistern to the time wherein it will be filled by all three pipes running together.*

I. If

houre cist. houre cist.

I. If $\frac{23}{9} - \frac{1}{1} - \frac{5}{8} - \left(\frac{45}{184}\right.$ } *filled by* { *A.* } *in* $\frac{5}{8}$ *houre*

II. If $\frac{10}{7} - \frac{1}{1} - \frac{2}{8} - \left(\frac{7}{16}\right.$ } *filled by* { *B.* } *in* $\frac{5}{8}$ *houre*

1 -- } *filled by* { *C.* } *in* $\frac{5}{8}$ *houre*

$1\frac{251}{368}$ } *filled by* { *A.B.C.* } *in* $\frac{5}{8}$ *houre*

cist. ho. cist.

III. If $1\frac{251}{368} - \frac{5}{8} - 1$

Facit $\frac{230}{619}$ *houre.*

Question 5. A *cistern* in a certain *conduit* hath three *pipes* or *cocks*, viz. *A*, *B*, and *C*, of such bignesse, that by *A*, the *cistern* will be filled in $\frac{1}{2}$ *houre*; by *B*, it will be emptied in $1\frac{3}{7}$ *houre*, and by *C* it will be emptied in $2\frac{1}{3}$ *houres*: Now since according to such proportion there will be more water infused by *A*, then evacuated by *B*, and *C*, running together; if all the three *cocks* bee set open at once, the question is to know in what time the *cistern* will be filled?

Facit $1\frac{9}{61}$ *houre.*

Finde how much of the cistern will be emptied in a certain time by B, *and* C, *running together, also how much of the cistern will be filled by* A *in the same time, so will the difference shew how much of the cistern is gained by the filling cock in the said time: Lastly as the cisterns or parts gained, is to the correspondent time; so is the whole cistern, to the time wherein it will be gained or filled.*

houre cist. houre cist.

I. If $2\frac{1}{3} - 1 - 1\frac{1}{7} - \left(\frac{22}{49}\right.$ } *emptied by* { *C* } *in* $1\frac{1}{7}$ *houre.*

1 - } *emptied by* { *B*

$1\frac{20}{49}$ } *emptied by* { *B & C*

houre cist. houre

II. If $\frac{1}{2} - 1 - 1\frac{1}{7} - \left(2\frac{6}{7}\right.$ *filled by A*

$1\frac{84}{343}$ *gained by A*

cist. houre cist.

III. If $1\frac{84}{343} - 1\frac{1}{7} - 1$

Facit $1\frac{9}{61}$ *houre, in which time the cistern will be filled.*

Question 6. Suppose a *Dog*, a *Wolf*, and a *Lion*, were to devoure a *Sheep*, and that the *Dog* could eat up the *Sheep* in an *houre*, the *Wolfe* in $\frac{3}{4}$ *houre*, and the *Lion* in $\frac{1}{2}$ *houre*; Now if the *Lion* begin to eat

eat $\frac{1}{8}$ *houre* before the other two, and afterwards all three eat together, the question is, in what time the *Sheep* would be devoured?

Facit $\frac{31}{104}$ *houre.*

houre Sheep houre.

I. If $\frac{1}{2}$ —— 1 —— $\frac{1}{8}$

Facit $\frac{1}{4}$ *eaten by the Lion before the Dog and Wolf began to eat.*

II. *Proceed according to the fourth question, so will you finde the remaining* $\frac{3}{4}$ *to be eaten by them all in* $\frac{9}{52}$ *houre, which added to* $\frac{1}{8}$ *gives* $\frac{31}{104}$ *houre, in which time the Sheep would be devoured.*

Question 7. If $120\frac{1}{3}$ lb. be to be distributed amongst three persons *A, B, C,* in such sort, that as often as *A* takes 5, *B* shall take 4; and as often as *B* takes 3, *C* shall take 2; what shall be the share of each?

Facit A $51\frac{4}{7}$ lb. *B* $41\frac{9}{35}$ lb. *C* $27\frac{53}{105}$ lb.

Finde three Numbers which may expresse the proportions of their shares, by the Rule of Three, or (to avoid Fractions) thus,

The

The Product of { 5 by 3 is 15; 3 by 4 is 12; 4 by 2 is 8 }

5	4
3	2
15-12-8	

The Proportions of their shares. { 15, 12, 8 }

35-$120\frac{1}{3}$ { l. 15-$51\frac{4}{7}$ for *A*; 12-$41\frac{9}{35}$ for *B*; 8-$27\frac{53}{105}$ for *C* }

Question 8. A *Governour* of a certain *Garrison*, being desirous to know how much money the *Port* or passage of the *Garrison* did amount unto in certain moneths, made choice of a loyall *servant*, giving him order to receive of every *coach man* passing with a *coach*, 4 d. of every *horseman* 2 d. and of every *footman* $\frac{1}{2}$ d. Now at the years end, the *servant* making his accompt to the *Governour*, giveth him 94 l. 15 s. 10 d. and lets him know that as often as 5 passed with *coaches*, 9 passed on *horseback*; and as often as 6 passed on *horseback*, 10 passed on foot; the question is, how many *coaches*, *horsemen* and *footmen* passed? Answ. 2500 *coaches*, 4500 *horsemen*, 7500. *footmen.*

Find 3 proportionall numbers after the manner of the seventh question, which will be 5. 9. 15. *then proceed as followeth,*

		s. d.
5	*Coaches*	1-8
9	*Horsemen*	1-6
15	*Footmen*	0-7 $\frac{1}{2}$

l. s. d.

Lastly, say if--3-9$\frac{1}{2}$-94.15.10 { 5-(2500, 9-(4500, 15-(7500

Question 9. A Factor would exchange 780 ℔. *sterling*, for *double ducats, dollars,* and *French crowns*, the *ducats* at 7 s. 6 d. the *piece*, the *dollars* at 4 s. 4 d. and the *French crownes* at 6 s. the *piece*; to be in such proportion, that $\frac{1}{4}$ of the number of *ducats*, may bee equall to $\frac{3}{8}$ of the number of *dollars*; and $\frac{2}{5}$ of the *dollars*, equall to $\frac{8}{15}$ of the *crownes*: the question is, how many *pieces* of each *coin* hee shall receive for his 780 pound. *Facit* 600 *ducats*, 900 *dollars*, 1200 *crownes*.

Finde three proportionall Numbers (after the manner of the seventh question) which will be 2, 3, 4.

$\frac{1}{4}$—

$\frac{1}{4}$ ———— $\frac{3}{8}$

$\frac{2}{5}$ ———— $\frac{8}{15}$

$\frac{1}{10}$.	$\frac{3}{20}$.	$\frac{1}{5}$
2.	3.	4

Then proceed as followeth,

℔.

2 *ducats*—$\frac{3}{4}$

3 *dollars*—$\frac{13}{20}$

4 *crowns*—1$\frac{1}{5}$

Say, if—2$\frac{3}{5}$—780 ℔. { $\frac{3}{4}$—(225, $\frac{13}{20}$—(195, 1$\frac{1}{5}$—(360 ℔.

℔.		℔.	
If $\frac{3}{8}$	—1 *ducat*	—225—	(600 *ducats*.
If $\frac{13}{60}$	—1 *dollar*	—195—	(900 *dollars*.
If $\frac{3}{10}$	— 1 *crown*	—360—	(1200 *crowns*.

Question 10. Twentie *Knights*, 30 *Merchants*, 24 *Lawyers*, and 24 *Citizens*, spent at a dinner 64 pound, which

was divided amongst them in such manner that 4 *Knights* paid as much as 5 *Merchants*, 10 *Merchants* as much as 16 *Lawyers*, and 8 *Lawyers*, as much as 12 *Citizens*; the question is to know the sum of money paid by all the *Knights*, also by the *Merchants*, *Lawyers* and *Citizens*?

Answer, the 20 *Knights* paid 20 pound, the 30 *Merchants* 24 pound, the 24 *Lawyers* 12 pound, and the 24 *Citizens* 8 pound.

Finde 4 Numbers to expresse the proportions of their payments, by the Rule of Three, *or (to avoid Fractions) in manner following, so will the proportionall numbers be* 4. 5. 8. 12. viz. 4 *Knights paid as much as* 5 *Merchants, or* 8 *Lawyers, or* 12 *Citizens.*

		4 —— 5
The	4, 10 8, is 320	10 —— 16
pro-	10. 8, 5, is 400	8 —— 12
duct	8, 5, 16, is 640	
of	5, 16, 12 is 960	320. 400. 640. 960
		4. 5. 8. 12

Then presuppose a summe for a Knight to pay, as 4 s. *and proceed as followeth*, viz.

20 *Knights*

	l s. d.	
20 *Knights*	4- 0-0	
30 *Merchants*	4-16-0	
24 *Lawyers*	2- 8-0	
24 *Citizens*	1-12-0	

Say if 12-16-0 - 64

	lb.
4--	20
$4\frac{4}{5}$--	24
$2\frac{2}{5}$--	12
$1\frac{3}{5}$-	8
	64

Question 11. A certain *man* with his *wife* did usually drinke out a *vessell* of *Beer* in 12 *dayes*, and the *husband* found by often experience, that his *wife* being absent, he dranke it out in twentie dayes; the question is, in how many dayes the wife alone would drinke it out?

Facit 30 dayes.

	dayes.
From	20
subtract	12

remains 8 *dayes of the husbands drinking, equall to* 12 *dayes of his wifes.*

Then say, If 8-12-20- (*Facit* 30 *dayes.*

Question 12. If a *house* be to be built by three severall *carpenters*, *A, B, C.* working in such sort, that *A* alone will finish it in 30 *dayes*, *B* in 40 dayes, and *A,B,C* together in 15 *dayes*, in what time would *C* build the *house?*

Facit 120 *daies.*

I. *Find in what time* A *and* B *working together will finish the house (after the manner of the* 4th *question.)*

Facit 17 $\frac{1}{7}$ *dayes.*

II. *Supposing the work of* A *and* B *to be performed by one person as* D, *the house will be built by* D *in* 17 $\frac{1}{7}$ *dayes, but by* D *and* C *in* 15 *dayes; then finde (according to the* 11th. *question) in what time* C *will finish the same.*

Facit 120 *dayes.*

The proof may be wrought according to the fourth question.

Question 13. Two *Travellers A* and *B*, perform a *Iourney* to one and the same place in this manner, *viz. A* travels 14 *miles* every day, and hath travelled eight *dayes* before *B* begins, upon the ninth day *B* sets forward, and travells 22 *miles* every day, the question is, in what time *B* shall overtake *A?*

Facit at the end of 14 *dayes.*

Find

Find how many miles B *gains of* A *in a day, which will be eight miles; also finde how many miles* A *had travelled before* B *did begin, which will be found* 112 *miles, then say*

miles *day* *miles*
If 8 —— 1 —— 112 —— (14 *dayes.*

Question 14. Suppose a Greyhound to be coursing of a Hare, in such sort that the Hare takes five leaps for every foure leaps of the Greyhound, and is one hundred leaps distant from the Greyhound; Now if three of the Greyhounds leaps be equall to foure leaps of the Hares, the question is, in how many leaps the Greyhound will obtain his prey?

Facit 1200 leaps.

I. If 3 —— 4 —— 4

Facit 5 $\frac{1}{3}$ *leaps of the Hare, equall to foure leaps of the Greyhound, and therefore the Greyhound in every foure of his leaps gains* $\frac{1}{3}$ *leap.*

II. If $\frac{1}{3}$ — 4 — 100 - (*Facit* 1200 *leaps.*

Question 15. There is a certain room whose Basis is a long square, which is in

 circuit

circuit $50\frac{1}{2}$ feete, and the height of the walls or sides of the room is $8\frac{1}{4}$ feet; Moreover in one side of the room there is a rectangular window, whose height is five feet, and breadth foure feet; Now the said room is to be furnished with hangings of Ell-broad stuffe at 3s. 4 d. the yard, the question is to know how much money the stuffe will cost?

Facit 5 l. 17 s. $6\frac{2}{9}$ d.

feet

Multiply $\begin{cases} 50\frac{1}{2} \text{ the compasse about} \\ 8\frac{1}{4} \text{ the height.} \end{cases}$

$416\frac{5}{8}$ *the Area of square feet in the sides of the roome.*

Subtr. $<$ 20 *the Area of the window.*

$396\frac{5}{8}$ *Area to be furnished with hangings.*

feet

$3\frac{3}{4}$

3

$11\frac{1}{4}$ *Area of feet in one yard of stuffe.*

If $11\frac{1}{4}$ feet——$3\frac{1}{3}$ s.——$396\frac{5}{8}$ feet

Facit 5 l. 17 s. $6\frac{2}{9}$ d.

Question

Question 16. There is a certain walk which is a long square, whose length is 40 yards, and breadth 7 yards, to bee paved with rectangular stones, each stone being 28 Inches in length, and 24 Inches in breadth, the question is to know how many such stones will be requisite to pave the said walk.

Facit 540.

I. *Finde the Area of the walke in feet or Inches.* viz.

Inches

$\left.\begin{matrix} 1440 \text{ the length} \\ 252 \text{ the breadth} \end{matrix}\right\}$ *of the walke.*

362880 *the Area of square Inches in the walke.*

II. *Finde the Area of square Inches in one of the stones.*

Inches.

$\left.\begin{matrix} 28 \text{ the length} \\ 24 \text{ the breadth} \end{matrix}\right\}$ *of a stone.*

672 *the Area of square Inches in a stone.*

III. If 672——1——362880

Facit 540 *stones.*

Question

Question 17. A *Merchant* would bestow 220l. in *Cloves*, *Mace* and *Nutmegs*, the *Cloves* being at 5 s. the pound, the *Mace* at 11 s. the pound, and the *Nutmegs* at 6 s. the pound; Now hee would have of each sort an equall quantitie, the question is how many pounds he may have of each sort?

Facit 200 ℔.

s.
5
11
6

As 22-1-4400 s.-(200℔. *waight*.

The proofe.

℔.		s.		l.
200	at	5	*amounts unto*—	50
200	at	11	*amounts unto*—	110
200	at	6	*amounts unto*—	60
				220

Question 18. A *Factor* is to receive a summe of money, and is offered *Dollars* at 4 s. 4 d. which are worth but 4s. 3 d. or *French Crownes* at 6 s. 1 $\frac{1}{2}$ d. which are worth but 6s. the question is by which *Coyne* he shall sustain the least losse?

Answer, the *Dollars*.

If 4 s. 4 d.-1 d.-6 s. 1 $\frac{1}{2}$ d.-(1 $\frac{42}{104}$ d.

That is, in receiving the Dollars every 6 s. 1 $\frac{1}{2}$ d. *looseth* 1 $\frac{42}{104}$ d. *but in receiving the Crownes*, 6 s. 1 $\frac{1}{2}$ *looseth*, 1 $\frac{1}{2}$ d. *which is a greater losse then* 1 $\frac{42}{104}$ d.

Question 19. A *Butcher* agrees with a *Grasier*, for the feeding of 20 *Oxen*, during the space of 12 moneths, accounting 30 dayes to a moneth, but at 2 moneths end, the *Butcher* addes 5 *Oxen* more, and 6 $\frac{2}{5}$ moneths after that, he addeth 10 *Oxen* more, and then it is agreed between them, that the *Grasier* shall feed them all, so long time as will be equivalent to the keeping of the first twenty during 12 moneths; the question is, how long time hee shall feed them all, after the putting in of the last 10? Examples of the Rule of Three Inverse.

Facit 1 *moneth.*

Consider, that as he receives more Oxen to feed, he ought to keep them all the lesse time; therefore work as the question imports, in reciprocall proportion.

mon.

mon. *Oxen*
12 20
2 5 *mon.* *Oxen*

If 20 — 10 — 25 — (8 25
$6\frac{3}{5}$ 10

If 25 — $1\frac{2}{5}$ — 35 - (1 *mon.*

Question 20. If a *Garrison* consisting of 230 *Souldiers*, be victualled to endure a *Siege* of 96 dayes, how many *Souldiers* must be dismist, to the end the said provisions may at the same proportion of expence, bee sufficient for the *Souldiers* remaining to endure a *Siege* of 184 dayes?

Facit 110 to be dismissed, and 120 to remain in *Garrison*.

dayes *Sould.* *dayes.*
If 96 — 230 — 184
Facit 120 to remain in Garrison.

Question 21. If when *Wheat* is at 24 s. the *quarter*, the penny white loaf ought to waigh 1 ℔. 1 *Oun.* 12. *p. w. Troy*, what ought it to waigh when *Wheat* is at 3 ℔. 12 s. the *quarter*?

Facit 4 *Ounces*, 10 *penny waight*, and 16 *grains*.

If

If $1\frac{1}{5}$ ℔. — $13\frac{3}{5}$ *Oun.* — $3\frac{1}{5}$ ℔.
1 —— 68 —— 15

Facit 4 *Oun.* 10 *p.w.* 16 *grains.*

Question 22. If $4\frac{3}{4}$ *yards* in length, of *Cloth* which is 6 *quarters* broad, will make a *Garment*, how much *stuffe* which is $\frac{5}{8}$ *yard* in breadth, will make a like *garment*?

Facit $11\frac{2}{5}$ *yards.*

breadth *length* *breadth.*
If $\frac{6}{4}$ *y.* — $\frac{19}{4}$ *y.* — $\frac{5}{8}$ *y.*
Facit $11\frac{2}{5}$ *yards.*

Question 23. If 13 *men* will reap 24 *Acres* in 2 *dayes*, in what time will 30 *men* reap 96 *Acres* at the same rate of working? Examples of the double Rule of Three.

Facit $3\frac{7}{15}$ *dayes.*

men *Acres* *men.*
I. 13 — 24 — 30 — (*Facit* $\frac{720}{13}$ *Acres.*

Acres *dayes* *Acres.*
II. $\frac{720}{13}$ — $\frac{2}{1}$ — $\frac{96}{1}$ — (*Facit* $3\frac{7}{15}$ *dayes.*

Question 24. If 350 *Pyoners* cast up a *Trench* of 200 *yards* in length in 24 houres,

houres, how many *yards* will 500 *Pyoners* cast up in 8 $\frac{1}{2}$ *houres* ?

Facit 101 $\frac{4}{21}$ *yards*.

Pyoners, *ho.* *Py.*

I. 350 — 24 — 500 — ($\frac{24}{5}$ *houres*.

II. $\frac{24}{5}$ *ho.* — $\frac{200}{1}$ *y.* -- $\frac{17}{2}$ *ho.* -(101 $\frac{4}{21}$ *yards*.

Examples of the Rule of Fellowship.

Question 25. Two *Merchants*, viz. *A*, and *B*, have entered *Company*; *A* puts in 500 lb. and at 4 *moneths* end takes out a certain summe leaving the remainder to continue 8 *moneths* longer; *B* puts in 250 lb. and at 5 *moneths* end puts in 300 lb. more, and so the whole summe continues 7 *moneths* longer. Now at the making of their *Accompt*, *A* findeth that hee hath gained 106 $\frac{2}{3}$ pound, and *B* gained 133 $\frac{1}{3}$ pound; the question is to know how much *A* tooke out of the *banke* at 4 *moneths* end?

Facit 240 lb.

B 250 lb.

lb. *mo.*

B. 250-5-1250 } *the Products of the money of* B *multiplied by the respective time.*

adde 300

550-7-3850

5100

133 $\frac{1}{3}$-5100-106 $\frac{2}{3}$-(4080 | 500l.

4 *mo.*

subtract 2000 — 2000

500

8) 2080(260

The money taken out by A-240

The proofe.

lb. *mo.*

A 500-4-2000 } *the Products of the money of* A *multipli. by the respective time.*

subtract 240

260-8-2080

4080

Note that this and such like questions of the *Rule* of *Fellowship* with time have respect unto *Simple Interest*; for the *shares*

of

of the *gain* or *loſſe* are in ſuch proportion as the particular *Simple Intereſts* of the *ſtocks* for the reſpective times.

Queſtion 26. Five *Merchants*, viz. *A*, *B*, *C*, *D* and *E*, have gained 2025 l. which they divide in ſuch ſort, that $\frac{1}{2}$ of the *ſhare* of *A* is equall to $\frac{1}{4}$ of the *ſhare* of *B*, or $\frac{1}{5}$ of *C*. or $\frac{1}{6}$ of *D*. or $\frac{1}{8}$ of *E*. the queſtion is, what was the *ſhare* of each *Merchant*?

Facit A 162 l. *B* 324 l. *C* 405 l. D 486 l. *E* 648 l.

Divide a number at pleaſure which may be in ſuch proportion as their ſhares, and proceed according to the ſubſequent Operation.

A 2
B 4
C 5
D 6
E 8

lb.

As—25-2025 { 2-(162 *for A whereof* $\frac{1}{2}$ *is* 81
4-(324 *for B whereof* $\frac{1}{4}$ *is* 81
5-(405 *for C whereof* $\frac{1}{5}$ *is* 81
6-(486 *for D whereof* $\frac{1}{6}$ *is* 81
8-(648 *for E whereof* $\frac{1}{8}$ *is* 81

2025

Queſtion 27. Two *Merchants A* and *B* are in *Company*, the ſum of their *ſtocks* is

is 300 l. the *money* of *A* continuing in company 9 *moneths*, the *money* of *B* 11 *moneths*, they gain 200 l. which they divide equally; the queſtion is to know how much each *Merchant* did put in?

Facit A 165 l. *B* 135 l.

Divide 300 *into two ſuch parts which may be in proportion as* 11 *to* 9, *ſo will the greater part be the ſtocke of* A, *and the leſſer the ſtocke of* B, *which ſtocks being multiplied by their reſpective times, the Products will be equall.*

11
9

As.—20—300 { 11—165 *for A*
9—135 *for B*

Queſtion 28. Two *Merchants*, viz. *A* and B are in *company*, *A* did put in 325 l. more then *B*, and the ſtock of *A* continued in *company* 7 $\frac{1}{2}$ *moneths*; *B* put in a certain ſumme which is unknown, and it continued in *company* 10 $\frac{3}{4}$ *moneths*, after a certain time they divide the gain equally; the queſtion is what each *Merchant* did put in?

Facit B 750 l. and *A* 1075 l.

Bb *Divide*

Divide the Product of the difference of their stocks and the time of A, *by the difference of their times, so will the quotient be the stock of* B. *which added to* 325l. *gives the stock of* A.

325
$7\frac{1}{2}$

$3\frac{1}{4}$) $2437\frac{1}{2}$ (750 *stock of* B
325

1075 *stock of* A

Examples of the Rule of Alligation alternate. How the finenesse of Silver is estimated. *Vid.* pa. 222.

Question 29. A *Goldsmith* hath divers sorts of *Silver*, viz. some of 11. *Ounc.* 13. *p. Fine,* other some of 10 *Ounces*, and another sort of 8 *Ounc.* 7 *p. fine*: the question is how much of each sort he ought to take, and how much *Alloy*, to the end he may produce a *Masse* of *Silver* waighing 18 lb. 10 *Oun.* and bearing 6 *Oun.* 12 *p.* 13 gr. *fine?*

Facit, he must take of each of the sorts of *Silver* 4 *pound*, 1 *Ounce*, 18 *p.* 11 $\frac{8}{15}$ grains, and of the *Alloy* 6 *pound*, 4 *Oun.* 4 *p.* 13 $\frac{3}{5}$ *grains.*

Oun.

Oun p.gr. *Oun.p.gr.*

Oun.p.gr. 6.12.13 { 11.13.0 | 10.00.0 | 8.07.0 | 0. 0.0 }

6.12.13
6.12.13
6.12.13
5. 0.11 } *Oun p.gr.*
3. 7.11 } 10. 2.9.
1.14.11 }

$\frac{1}{3}$.6. 0. 0.

If 2 lb. 6 *Oun.* — 18 lb. 10 *Oun.* — 6 *Oun.* 12 *p.* 13. *gr.*

Facit 4 lb. 1 *Oun.* 18 *p.* 11 $\frac{8}{15}$ *gr.*

If 2 lb. 6 *Oun.* — 18 lb 10 *Oun.* — 10 *Oun.* 2 *p.* 9 *gr.*

Facit 6 lb. 4 *Ounces* 4 *peny w.* 13 $\frac{3}{5}$ *gr.*

Question 30. A *Vintner* having divers sorts of *wines*, viz. some that stands him in 4 s. 2 d. the *Gallon*, other some of 3 s. 4 d. the *Gallon*, some again of 2 s. 3 d. the *Gallon*, and other some of 1 s. 8 d. the *Gallon*, is desirous to fill a *Hogshead* containing 63 *Gallons* with a mixture of these *wines* which he may afterwards afford for 2 s. 8 d. the *Gallon*: How much of each sort ought he to take?

 Facit

Facit 17 *Gallons*, 4 $\frac{28}{43}$ *pints* of the first sort; 7 *Gallons* 2 $\frac{26}{43}$ *pints* of the second; 11 *Gallons* 5 $\frac{33}{43}$ *pints* of the third; and 26 *Gallons* 2 $\frac{42}{43}$ *pints* of the last sort.

	s. d.	s. d.
s. d.	4 . 2	1 . 0
2 . 8	3 . 4	0 . 5
	2 . 3	0 . 8
	1 . 8	1 . 6
		3 . 7

s. d. *gal.* s. *gal.* *pint.*
If 3 . 7 — 63 — 1 — (*Facit* 17 : 4 $\frac{28}{43}$

s. d. *gal.* d.
If 3 . 7 — 63 — 5 — (*Facit* 7 : 2 $\frac{26}{43}$

s. d. *gal.* d.
If 3 . 7 — 63 — 8 — (*Facit* 11 : 5 $\frac{33}{43}$

s. d. *gal.* s. d.
If 3 . 7 — 63 — 1 . 6 — (*Facit* 26 : 2 $\frac{42}{43}$

See *Chap.* 4. of this Appendix.

Question 31. An *Apothecary* hath severall *Simples*, viz. *A hot* in 3°. *B hot* in 2°. *C temperate*, *D cold* in 2°. and *E cold* in 4°. Now he desires to make a *Medicine* of those *Simples*, in such sort that the *temper* thereof in respect of *qualitie* may be in 1°. of *heat*, and the *quantitie* 8 $\frac{1}{2}$ *Drams*

Drams, the demand is what quantitie of each *Simple* he must take?

Facit 4 $\frac{1}{2}$ *Drams* of *A*. $\frac{1}{2}$ *Dram* of *B*. 1 $\frac{1}{2}$ *Dram* of *C*. 1 *Dram* of *D*. and 1 *Dram* of *E*.

	Degr.		*Drams.*	
	8	1, 3, 5	9	*A.*
	7	1	1	*B.*
6	5	2, 1	3	*C.*
	3	2	2	*D.*
	1	2	2	*E.*
			17	

Drams

If 17 — 9 — 8 $\frac{1}{2}$ — (*Facit* 4 $\frac{1}{2}$ | *A*.
If 17 — 1 — 8 $\frac{1}{2}$ — (*Facit* $\frac{1}{2}$ | *B*.
If 17 — 3 — 8 $\frac{1}{2}$ — (*Facit* 1 $\frac{1}{2}$ | *C*.
If 17 — 2 — 8 $\frac{1}{2}$ — (*Facit* 1 | *D*.
If 17 — 2 — 8 $\frac{1}{2}$ — (*Facit* 1 | *E*.

8 $\frac{1}{2}$

Examples of the Rule of False position.

Question 32. A *Merchant* buyeth 2 sorts of *Clothes*, viz. of *blacke* and of *white* for 68 lb. 2 s. after the rate of 21 s.

the *yard* for the *blacke*, and 12 s. the *yard* for the *white*, and he taketh so much of each sort, that $\frac{5}{6}$ of the number of *yards* of the *blacke*, are equall to $\frac{7}{8}$ of the *white*; the demand is, how many *yards* he bought of each sort?

Facit 42 *yards* of *blacke*, and 40 *yards* of *white*.

Question 33. A certain *Usurer* putteth forth 186 l. at *Simple Interest*, which in a certain time gaineth 36 *Dollars*: Also at the same rate of *Interest per centum*, he putteth forth 360 l. which gaineth in a certain time 90 *Dollars*; Now the summe of the *moneths* wherein both the said numbers of *Dollars* were gained is 20 *moneths*, The *question* is to know in what time the 36 *Dollars*, also the 90 *Dollars* were gained?

Facit the 36 *Dollars* were gained in 8 $\frac{8}{11}$ *moneths*, and the 90 *Dollars* in 11 $\frac{3}{11}$ *moneths*.

The proofe may be wrought by the double Rule of Three.

Quest. 34. A *Merchant* putteth forth 2500 l. for 4 *yeares* at 8 *per Cent. per Ann.* in such manner, that at the end of each of the said 4 yeares, he is to receive an

an equall summe, and that at the 4 yeares end, as well the *Capitall* as the *Interest* may be satisfied; the question is, what summe of money ought to be paid at every yeares end?

Facit 754 $\frac{14117}{17602}$ l. *as will be manifest by the subsequent proofe.*

I. 100 — 108 — 2500 — (2700
subtract the first payment — 754 $\frac{14117}{17602}$

1945 $\frac{3485}{17602}$

II. 100 — 108-1945 $\frac{3485}{17602}$ —(2100 $\frac{14325}{17602}$
subtract the 2d. *payment* —754 $\frac{14117}{17602}$

1346 $\frac{208}{17602}$

III. 100 —108-1346 $\frac{208}{17602}$ — (1453 $\frac{12194}{17602}$
subtract the 3d. *payment*. — 754 $\frac{14117}{17602}$

698 $\frac{15679}{17602}$

IV. 100 —108- 698 $\frac{15679}{17602}$ —(754 $\frac{14117}{17602}$
the last payment, — 754 $\frac{14117}{17602}$

0

the *yard* for the *blacke*, and 12 s. the *yard* for the *white*, and he taketh so much of each sort, that $\frac{5}{6}$ of the number of *yards* of the *blacke*, are equall to $\frac{7}{8}$ of the *white*; the demand is, how many *yards* he bought of each sort?

Facit 42 *yards* of *blacke*, and 40 *yards* of *white*.

Question 33. A certain *Usurer* putteth forth 186 l. at *Simple Interest*, which in a certain time gaineth 36 *Dollars*: Also at the same rate of *Interest per centum*, he putteth forth 360 l. which gaineth in a certain time 90 *Dollars*; Now the summe of the *moneths* wherein both the said numbers of *Dollars* were gained is 20 *moneths*, The *question* is to know in what time the 36 *Dollars*, also the 90 *Dollars* were gained?

Facit the 36 *Dollars* were gained in 8 $\frac{4}{11}$ *moneths*, and the 90 *Dollars* in 11 $\frac{7}{11}$ *moneths*.

The proofe may be wrought by the double Rule of Three.

Quest. 34. A *Merchant* putteth forth 2500 l. for 4 *yeares* at 8 *per Cent. per Ann.* in such manner, that at the end of each of the said 4 yeares, he is to receive an

an equall summe, and that at the 4 yeares end, as well the *Capitall* as the *Interest* may be satisfied; the question is, what summe of money ought to be paid at every yeares end?

Facit 754 $\frac{14117}{17602}$ l. *as will be manifest by the subsequent proofe.*

I. 100 — 108 — 2500 — (2700
subtract the first payment — 754 $\frac{14117}{17602}$

1945 $\frac{3485}{17602}$

II. 100 — 108 - 1945 $\frac{3485}{17602}$ — (2100 $\frac{14325}{17602}$
subtract the 2d. *payment* — 754 $\frac{14117}{17602}$

1346 $\frac{208}{17602}$

III. 100 — 108 - 1346 $\frac{208}{17602}$ — (1453 $\frac{13194}{17602}$
subtract the 3d. *payment.* — 754 $\frac{14117}{17602}$

698 $\frac{15679}{17602}$

IV. 100 — 108 - 698 $\frac{15679}{17602}$ — (754 $\frac{14117}{17602}$
the last payment, — 754 $\frac{14117}{17602}$

0

Chap VII.

Containing sundry pleasant and choice Questions, which may serve as a Recreation, to new beginners in Algebra *by Species.*

An Explanation of the Signes or Notes, used in the Questions of this Chapter.

1. This *Character* ✢ represents the words *more by*, and is the signe of *Addition* or *Affirmation*; So 8 ✢ 4 signifie 8 *more by* 4, or 4 added to 8, or the *summe* of 8 and 4, that is, 12.

2. This *Character* — denotes the words *lesse by*, and is the signe of *Subtraction* or *Negation*; So 12 — 3 signifie 12 *lesse by* 3, or 3 subtracted from 12, or the difference between 12 and 3, that is, 9.

3. This *Character* $=$ represents the words equall to, and is the note of an *Æquation*; So 7 ✢ 3 $=$ 6 ✢ 4 are to be read *thus*, 7 *more by* 3, is equall to 6 *more by* 4; In like manner in *Species* or *Letters*, viz. If *A* be 5, *B* 4. *C* 12, and *D* 3. then

A ✢ *B* $=$ *C* — *D* are to be read thus; *A more by B* is equall to *C*, *lesse by D*, that is, 5 ✢ 4 $=$ 12 — 3 or 5. *more by* 4 is equall to 12 *lesse by* 3; that is, 9 is equall to 9.

4. Two or more *Letters* conjoyn'd without any note between them, signifie the *Product* of the numbers represented by those *Letters*; So if *A* be 6, and *B* 4. then *A B* signifies the *Product* of 6 multiplied by 4, that is, 24: Also if *B* be 5, *C* 7, and *D* 8. then *B C D* signifies the *Product* arising from the *continuall Multiplication* of the numbers 5, 7, and 8; that is. 280.

5. *Letters* placed in form of a *Fraction*, viz. above and beneath a line signifie a *Quotient* arising from the *division* of the numbers represented by the *letters* above the line, or the *Dividend*, by the numbers represented by the *letters* underneath the line, or the *Divisor*: So if *B* be 12 and *C* 4. then $\frac{B}{C}$ that is, (in the *Analyticall* phrase) *B applied* to *C*, signifies $\frac{12}{4}$ which is equall to the *quotient* of 12 divided by 4; that is, 3. In like manner if *A* be 5. *B*, 6. *C*, 3, and *D*, 2, then by $\frac{A\ B}{C ✢ D}$ is

underſtood, the *quotient* ariſing from the *diviſion* of the *Product* of 5 and 6; (that is 30) by the *ſumme* of 3 and 2 (that is 5) which *quotient* will be 6; for 30 being divided by 5 quoteth 6.

6. *Foure points* placed *thus* ∷ denote the middle of 4 *Proportionalls*: So if *A* bee 3, *B* 12, *C* 4, then $A.B :: C. \frac{BC}{A}$ are to be read *thus*: As *A* is to *B*, ſo is *C* to $\frac{BC}{A}$ or if *A* give *B*, then *C* will give $\frac{BC}{A}$ that is, as 3 is to 12, ſo is 4 to $\frac{48}{3}$ (or 16.)

7. This *letter q* placed next after a *Capitall letter* denotes the *Quadrate* or *Square* of the number repreſented by ſuch *Capitall letter*; So if *A* be 7, then by *A q* is ſignified the *ſquare* of 7, that is 49: Alſo *q q* is the ſigne of a *biquadrate*; So if *C* be 2, then *Cqq* ſignifies the *biquadrate* of 2, that is 16: In like manner the ſmall letter *c* placed next after a *capitall letter*, is the ſign of the *Cube* of the number repreſented by ſuch *capitall*; ſo if *A* be 2, then by *A c* is ſignified 8; that is, the *Cube* of 2.

8. This

8. This *Character* √ denotes the *ſquare root* of the *ſquare number* repreſented by the *Species* placed next after ſuch *character*: So if *Aq* or the *ſquare* of *A* be 16, then *A* or √ *Aq* is 4. In like manner √*c*. denotes the *Cube root*; √*qq* the *biquadrate root*: But if a *Poteſtas* (whether it be a *ſquare Cube*, &c.) compounded of many letters, be included between two *colons*, *viz.* there being two points placed both before and after the ſaid *letters*, then the aforeſaid ſignes denote the root univerſall relating to all the *letters* ſo included: So if *Cq* be 25 and *N* 9. then by √*u*: *Cq* — *N*: is underſtood 4 being the *ſquare root* of the remainder after *N* is ſubtracted from *Cq*, *viz.* 25 *leſſe by* 9 is 16, whoſe *ſquare root* is 4.

Of the method uſed in the Queſtions of this Chapter.

That wch I principally aim at in this *Chap.* is, to give the ingenious *Reader*, whom I preſuppoſe to be in ſome meaſure acquainted with the *Elements* or parts of *Specious* or *Symbolicall Arithmetique*, a taſt of the *Praxis* of *Algebra* in *Species*, in ſuch *queſtions* which may exerciſe ſome of the principall *Rules* hitherto invented, for the reſo-

reſolution of *Æquations* in numbers: And ſince in the proceſſe of the work there may be different methods, I conceive it will bee neceſſary to give ſome generall *Rules* and directions for the better underſtanding of the ſubſequent queſtions, and therefore you may obſerve as followeth, *viz.*

A *Queſtion* being propounded, it will be convenient (for the avoyding of confuſion) to repreſent *known quantities* by *Conſonants*, and *unknown* by *Vowels*: And when after due ratiocination and proceſſe made, either by *adding*, *ſubtracting*, *multiplying* or *dividing*, according to the conditions in the queſtion, an *Æquation* is found, it is to be reduced (if need require) either by *Depreſſion*, *Tranſpoſition*, *Application* or other *Rules* of *Analyticall Reduction*, in ſuch ſort that thoſe quantities which are known and not compounded with unknown, may ſolely poſſeſſe one part (or ſide) of the *æquation*, and thoſe which are unknown, the other, which unknown part of the *æquation* may bee conſidered in a threefold reſpect, *viz.*

The

The unknown part of the æquation is either
- 1. *Pure.*
- 2. *A Poteſtas.*
- 3. *Adfected.*

The unknown part of the *æquation* is ſaid to be *Pure*, when the ſide or number unknown is found to be equall to a known quantitie whether the ſaid known quantity be expreſt by one *Conſonant* or a *Summe*, *Difference*, *Rectangle* or *Quotient* expreſt by two or more *conſonants*, as in the 5th. *Æquation* of the 6th. *Queſtion*, where $A = 5$. Alſo in the 7th. *Æquation* of the firſt *queſtion*, where $A = \frac{C + B.}{2}$ In like manner in the 11th. *Æquation* of the 4th. *Queſtion*, where $A = \frac{BqD}{C2D - BD}$ and the like may be found in the 10th. of the 3d. the 11th. of the 5th. *queſtions*, &c. which kind of *Æquations* are reſolved either by *Addition*, *Subtraction*, *Multiplication* or *Diviſion*, as the known part of the *Æquation* will ſhew.

2. The unknown part of the *Æquation*

tion

tion is said to be a *Potestas*, when the *Quadrate*, *Cube* or other *Power* of the quantity unknown, is found to be equall to a known quantity; as in the 8th. *Æquation* of the 13th. *Question*, where $A\,c. = \frac{B}{2}$ Also in the 9th. *Æquation* of the 14th. *Question*, where $A\,q = \frac{R\,B}{S}$ which kind of *Æquations* are resolved by extracting the Root of the known quantity, according to the signe annexed to the *Potestas* of the quantity unknown, as in the afore mentioned *Æquation* where $A\,c. = \frac{B}{2}$. the *Cube root* of $\frac{1}{2}$ of the known number represented by B is the value of the *Number* or *Thing* represented by A: Also where $A\,q = \frac{R\,B}{S}$ the *square root* of the *Quotient* found by dividing the *Product* of the known numbers R and B, by the known number S, is the value of the *Number* or *Thing* represented by A.

3. Of *Adfected Æquations* there are divers kinds, but in this place I shall onely have occasion to mention such as will be found in some of the *subsequent questions, viz.* when the unknown part of the *Æquation* consists of two *Termes*, one of which is some *Potestas* of the quantitie unknown, and the other is a *Rectangle* under the *side* (or some *Potestas* of the quantity unknown) and some known quantity, (whether the said known quantity bee represented by one *Consonant*, or a *Summe*, *Difference*, *Rectangle* or *Quotient* represented by 2 or more *Consonants*) which known quantity is by some *Authors* called the *Coefficient*, and such *Æquations* will fall under some of the three following *varieties, viz.*

$$\left.\begin{array}{l|l|l} 1. & C\,A - A\,q = N & C\,A\,q - A\,q\,q = N \\ 2. & A\,q + C\,A = N & A\,q\,q + C\,A\,q = N \\ 3. & A\,q - C\,A = N & A\,q\,q - C\,A\,q = N \end{array}\right\}\text{and such like.}$$

In each of which *equations* you may observe 3 *Termes*, the *Indices* or *Exponents* of whose *Degrees* do equally ascend in an *Arithmeticall Proportion, viz.* the *Index* or *Exponent* of the known quantity solely possessing one side of the *equation* represented by N, being the *lowest degree* of the *equation*; the *Exponent* of the

the side or *Potestas* of the quantity unknown which is drawn into the *Coefficient*, being the *middle degree* of the *æquation*; and the *Exponent* of the *Potestas* of the quantity unknown which hath no *Coefficient*, being the *highest degree* of the *æquation*: So that assuming o to bee the *Index* or *Exponent* of *N*, the *Exponents* of the *degrees* in each of the aforesaid 3 *æquations* on the left hand, will be o. 1. 2. and the *Exponents* of the other three *æquations* will be o. 2. 4.

Now the *adfected æquations* before mentioned, and such like, are resolved by certain generall *Rules* or *Theoremes* demonstrated by divers *Authours*, which *Rules* to the end the *subsequent questions* may be the more usefull: I shall expresse as well in *Symbols* as in *words*; and as touching other *adfected æquations*, the *Exponents* of whose *degrees* keep not an *Arithmeticall proportion*, the curious *Reader* may find what is hitherto known, in the works of the learned and famous modern *Analysts*, viz. the works of *Vieta*, *Mr. Oughtreds Clavis Mathemat. Limat. Mr. Harryots Ars Analytica*, *Renatus des Cartes* his *Geometry* in *French*; Also the same translated into *Latine* by *Fran.*

Fran. Schooten, with his *Commentary* thereupon, and the *Appendix* concerning *Cubicall æquations*, annexed unto the said *Fran. Schootens Treatise* of the description of *Conicall sections in Plano*.

In the first of the afore mentioned *æquations*, *viz.* $CA - Aq = N$ where the *highest degree is negative*, the value of *A* or the quantity unknown will be dubious, *viz.* there will be two *sides* or *numbers* found, either of which may bee the value of *A*, which *sides* or *numbers* will be found by the following *Rule*, *viz.*

In the Æquation $CA - Aq = N$.

$$\text{Rule I.}\begin{cases}\dfrac{C}{2} + \surd u : \dfrac{Cq}{4} - N := A \text{ the greater.}\\[2ex] \dfrac{C}{2} - \surd u : \dfrac{Cq}{4} - N := A \text{ the lesser.}\end{cases}$$

That is to say in words, If half the Coefficient (represented by C,) be increased with the Square root *of the remainder found by subtracting the known quantity (represented by N) from* $\frac{1}{4}$ *of the Square of the Coefficient, the summe will be the greater number or side sought: Or if half the Coeffici-*

efficient be lessened by the Square root *of the remainder found &c. the remainder will be the lesser.*

By which *Rule* the 6th. *æquation* of the 15th. question; also the 8th. of the 16th. the 10th. of the 17th. the 11th. of the 18th. and the 12th. of the 19th. are resolved.

In the 2d. of the afore mentioned *æquations* where $A q + C A = N$, the value of A, or the quantity unknown will be found by the following *Rule*, viz.

In the æquation, $A q + C A = N$.

Rule II. $\left\{ \sqrt{u} : \frac{C q}{4} + N : - \frac{C}{2} = A. \right.$

That is to say in words, If the Square root *of the summe of* $\frac{1}{4}$ *of the Square of the Coefficient (represented by C) and the known quantitie (represented by N) be lessened by half the Coefficient, the remainder will be the number or side sought.*

By which *Rule*, the 6th. *æquation* of the 20th. Question; also the 21th. of the 21th. and the 10th. of the 22th. are resolved.

In the 3d. of the afore mentioned *æquations*, where $A q - C A = N$, the value of A or the *quantity sought* will be found by the following *Rule, viz.*

In

In the Æquation, $A q - C A = N$.

Rule III. $\left\{ \frac{C}{2} + \sqrt{u} : \frac{C q}{4} + N : = A \right.$

That is to say in words, If half the Coefficient (represented by C) be increased with the Square root of the summe of $\frac{1}{4}$ *of the square of the Coefficient, and the known quantity (represented by N) the Aggregate will be the number or side sought.*

By which *rule* the 13th. *æquation* of the 23th. Question; also the 16th. of the 24th. are resolved.

Note that in any of the afore mentioned *æquations* when the *Coefficient* is drawn into some *Potestas* of the quantity sought, that is, when the *middle degree* of the *æquation* is a *Square, Cube, &c.* as $C A q - A q q = N$, or $C A c - A c c = N$ and such like, then the afore mentioned *rules* do find the value of such *Potestas* of the quantity sought, and therefore the *root* thereof is to be extracted according to its kind, as in the 12th. *equation* of the 19th. Question; also the 10th. of the 22th.

Moreover, when no *Species* is drawn into the quantity unknown, which is of the middle degree of the *equation*, then 1 or

 unity

unity is the *Coefficient* of such quantity: as in this *aequation*, $Aq + A = N$. and such like.

The *Demonstration* of the three *rules* before mentioned, will be manifest by *Sect.9. Cap.* 16. of the aforesaid *Clavis Mathemat.* Also by the third and fourth *Diagrams* in *Renat. Des Cartes* his *Geometrie.*

The questions follow:

Question 1. *There are two numbers whose summe is 26, and their difference is 8; what are the numbers?*

1	Let the *summe* of the two numbers be ——	B
2	Let the *difference* be	C
3	Let the *greater number* be —— ——	A
4	It is evident that if the *greater number* be subtracted from the *summe*, the remainder will be the *lesser*; therefore the first *aequation* lesse by the third, will be equall to the *lesser number*, which is —— ——	$B - A$

5	It is also manifest, that if the *lesser number* be subtracted from the *greater*, the remainder will bee the *difference* between them; therefore the 3d. *aequation* lesse by the 4th. will be equall to the 2d. *aequation*, viz.	$A - B + A = C$
6	The 5th. *aequation* by *transposition* of $-B$ will be ——	$2A = C + B$
7	If both parts of the 6th. be *applied* to 2. it will be —— ——	$A = \frac{C + B}{2}$

Which last *aequation*, in words, is the following *Theoreme, viz.*

Half the summe of the summe and difference of any two numbers is equall to the greater number.

Illustration.

The *summe* of the two numbers in the question is —— —— —— ——	26
The *difference* given is —— ——	8
Therefore the *summe* of the *summe* and *difference* is —— —— —— ——	34

But according to the afore mentioned *Theoreme*, half the *summe* of the *summe* and *difference* is equall to the *greater*; therefore the *greater number* is —— 17

Also if the *greater number* bee subtracted from the *summe*, the remainder will bee the *lesser*, therefore the *lesser number* is —— 9

So the two numbers sought are found to be 17 and 9, whose *summe* is 26. and *difference* 8, as was propounded.——

Otherwise.

1	Let the *summe* be	B
2	Let the *difference* be ——	C
3	Let the *lesser number* be ——	A
4	Then for as much as the *lesser number* together with the *difference* are equall to the *greater*, therefore the *summe* of the second and third *aequations* is equall to the greater number which is ——	$C + A$

5. And

5	And since the *greater number* together with the *lesse* are equall to the *summe*; therefore the *summe* of the third and fourth *aequations* is equall to the first, *viz.*	$C + 2A = B$
6	The fifth *aequation* by *transposition* of C, is —	$2A = B - C$
7	If both parts of the 6th. *aequation* be *applied* to 2, it will be ——	$A = \frac{B - C}{2}$

Which 7th. *aequation*, in words, is the following *Theoreme*, *viz.*

Half the difference between the summe and difference of any two numbers, is equal to the lesser number.

Illustration.

The *summe* of the two numbers given is —— 26

The *difference* given is —— 8

Therefore the *difference* between the *summe* and *difference* is —— 18

But according to the afore mentioned *Theoreme, half the difference* &c. therefore the *lesser number* is —— 9

	Alſo the *leſſer number* together with the *difference* are equall to the *greater*; therefore the *greater number* is ——	17

So the 2 Numbers ſought are found to be 9 and 17, whoſe *ſumme* is 26, and *difference* 8, as was propounded.

Queſtion 2. A certain man being demanded what was the age of each of his 4 ſonnes; anſwered, that his eldeſt ſonne was 4 yeares elder then the ſecond; his ſecond ſonne was 4 yeares elder then the third; his third ſonne was 4 yeares elder then the fourth or youngeſt; and his fourth or youngeſt ſonne was halfe the age of the eldeſt; the queſtion is, what was each ſonnes age?

1	Let the foure *yeares* mentioned in the queſtion be ——	B
2	Let the age of the *youngeſt ſonne* be ——	A
3	Then ſince the third *ſonne* was foure *yeares* elder then the youngeſt, the ſumme of the firſt and ſecond *æquations* will bee the age of the third *ſonne*, *viz.*	$A + B$

4. Again

4	Again, ſince the ſecond *ſonne* was foure *yeares* elder then the third; therefore the ſum of the firſt and third *æquations* will bee the age of the ſecond *ſonne*, *viz.*	$A + 2B$
5	Alſo ſince the *eldeſt ſonne* was foure *yeares* elder then the ſecond; therefore the ſumme of the firſt and fourth *æquations* will be the age of the *eldeſt ſonne*, *viz.*	$A + 3B$
6	And ſince the age of the *youngeſt ſonne* was half the age of the *eldeſt*; therefore the double of the ſecond *æquation* is equall to the fifth, *viz.* ——	$2A = A + 3B$
7	If A bee *ſubtracted* from both parts of the ſixth, it will be ——	$A = 3B$
8	By the firſt, it will be manifeſt that ——	$3B = 12$

Therefore

Therefore *A* or the age of the *youngest son* was 12 *years*, and consequently the age of the 3d. *son* was 16. the age of the *second*, 20. and the age of the *eldest* 24. which is double the age of the *youngest* as was propounded.

Quest. 3. *A certain Turk in his journy to Mecha, to visit the Tomb of Mahomet, meets with a Pilgrim who begs an almes, to whom the Turk answers, If by thy prayer to Mahomet, thou canst cause the Dollars which I have in my purse to be doubled, I will give thee* 8 *Dollars; which the Pilgrim effected, and accordingly received* 8 *Dollars as a reward: In like manner the Turk meets with another Pilgrim, who by his prayer caused the Turks remaining Dollars to be doubled, and received* 8 *Dollars as a reward: And lastly, the Turk meets with a third Pilgrim, who by his prayer caused the Turks remaining Dollars to be doubled, and received* 8 *Dollars as a reward, and so the Turk had no Dollars left; The question is how many Dollars he had at the first?*

1	Let 8 the number of *Dollars* which the *Turk* gave to each *pilgrim* be —	B
2	Let the number of *Dollars* which the *Turk* had in his purse at first be	*A*
3	The number of *Dollars* which the *Turk* had in his purse being doubled, by virtue of the first *Pilgrims* prayer produce —	2 *A*

4. If

4	If the first *æquation* be subtracted from the third, the remainder is the number of *Dollars* which the *Turk* had left when hee departed from the first *Pilgrim*, *viz.* —	2 A — B
5	The *Dollars* which the *Turk* had in his purse when hee met with the second *Pilgrim*, viz. 2 A — B (the fourth *æquation*) being doubled produce —	4 A — 2 B
6	If the first *æquation* be subtracted from the fifth, the remainder is the number of *Dollars* which the *Turk* had left when he departed from the 2d. *Pilgrim*, *viz.*	4 A — 3 B
7	The *Dollars* which the *Turk* had in his purse when hee met with the third *pilgrime*, *viz.* 4 A — 3 B (the sixth *æquation*) being doubled produce —	8 A — 6 B

If

8 | If the first *æquation* bee subtracted from the seventh, the remainder (according to the question) must be equall to o, therefore ——— | $8A - 7B = 0$

9 | The eighth *æquation* by *transposition* of — 7 B will be ——— | $8A = 7B$

10 | If both parts of the 9^{th} be *applied* to 8, it will be ——— | $A = \frac{7B}{8}$

But by the first *æquation* $\frac{7B}{8}$ will be found 7, therefore A or the number of *Dollars* which the *Turk* had in his purse at the first was 7. which will answer the conditions in the *question*.

Question 4. *A countrey maid going to the market, being asked by one that met her, how many eggs she had in her basket; answered, if she had 7 eggs more, she should make as much money in selling them all at 4 a penny, as in selling those which she had at 7 for 2 pence; The question is, how many eggs she had in her basket?*

1 | Let the 7 *eggs* in the question be ——— | B

2 | Let the 4 *eggs* in the question be ——— | C

3 Let

3 | Let 1 *penny* (the price of foure *eggs*) be | D

4 | Then will 2 *pence* the price of 7 *eggs* be —— | $2D$

5 | Let the number of *eggs* in the basket be — | A

6 | Find the price of all the *eggs* in the basket at the rate of seven *eggs* for two *pence*, and *say*, $B . 2D : : A . \frac{2DA}{B}$ So will the full price be ——— | $\frac{2DA}{B}$

7 | Again, adding seaven to the number of *eggs* in the basket, finde the price of that summe, after the rate of foure *eggs* for one penny, and *say*, $C . D : : A + B . \frac{DA + DB}{C}$ So will the full value be | $\frac{DA + DB}{C}$

8 And

8 And since the two severall sums of money, computed as aforesaid, according to the conditions in the question, ought to bee equall, therefore the 7^{th}. *æquation* is equall to the 6^{th}. *viz.* —— $\frac{DA + DB}{C} = \frac{2DA}{B}$

9 The 8^{th}. *æquation* reduced, will be —— $BDA + BqD = C2DA$

10 The 9^{th}. *æquation* by transposition of BDA, will be —— $BqD = C2DA - BDA$

11 If both parts of the 10^{th}. bee applyed to $C2D - BD$ it will be —— $\frac{BqD}{C2D - BD} = A$

12 The first part of the last *æquation* being resolved into number will be 49, which shewes that A or the number of *eggs* which the Maid had in her basket was 49.

Question 5. A Gentleman hires a servant for a twelve moneth, for 6 pounds, and a Livery Cloake valued at a certain rate, but at seven moneths end they falling at variance, the Gentleman

man puts away his servant, and gives him the Cloake, together with 50 shillings in money; and so the servant was fully satisfied for his time: the question is, what the Cloake was valued at?

1 Let the 12 *moneths* mentioned in the *question* be —— B

2 Let the 7 *moneths* mentioned in the *question* be —— C

3 Let the 6 *pounds* mentioned in the *question* be —— D

4 Let the $2\frac{1}{2}$ *pounds* which the *Servant* received be —— F

5 Let the *Cloake* be —— A

6 Find what part of the *Cloake* was due to the *Servant* at 7 *moneths* end, and say, B . A : : C . $\frac{CA}{B}$. So the part of the *Cloake* due to the *Servant* at 7 *moneths* end, was —— $\frac{CA}{B}$

7 Find

7 Find what part of the 6 lb. was due to the *Servant* at 7 *moneths* end, and say, B.D : : C. $\frac{DC.}{B}$ — $\frac{DC}{B}$

So the *money* due to the *Servant* at 7 *moneths* end, was —

8 Forasmuch as the *Cloake*, together with the money which the *Servant* received, ought to be equall to the part of the *Cloake* together with the part of the 6 *pounds*, due to the *Servant* at 7 *moneths* end; therefore the sum of the 4th. and 5th. *aquations* must be equall to the summe of the 6th. and 7th. *aquations, viz.* — $F + A = \frac{CA + DC}{B}$

The 8th. *aquation* reduced will be — $BF + BA = CA + DC$

10 The

10 The 9th. *aquation* by transposition will be — $BA - CA = DC - BF$

11 If both parts of the 10th. be applied to $B - C$ it will be — — $A = \frac{DC - BF}{B - C}$

The latter part of the 11th. being resolved into number, will be 2 $\frac{2}{5}$ *pounds*, which shewes that *A* or the *cloak* was valued at 2 l. 8 s.

Question 6.

Mulæ, Asinaque duos imponit servulus utres
Impletos vino; segnemque ut vidit Asellam
Pondere defessam vestigia figere tarda,
Mula rogat: quid chara pares cunctare, gemisq;?
Vnam ex utre tuo mensuram si mihi reddas,
Duplum oneris tunc ipsa feram; sed si tibi tradam
Vnam mensuram, fient æqualia utrique
Pondera: mensuras dic docte Geometer istas?
Facit, Mul. 7. Asin. 5.

1 Let the measures which the Asse carried be — — — A

2 Then according to the question, the Asses measures increased with 1 measure taken from the Mule will bee equall to the Mules remaining measures; therefore the Mules remaining measures were — $A + 1$

If

3 If 1 be added to the 2^{d} *equation*, it gives the number of *measures* which the Mule had at the first, *viz.* $A + 2$

4 According to the question, the Mules measures increased with 1 measure taken from the Asse, will be equall to the double of the Asses remaining *measures*, viz. $A + 3 = 2A - 2$

5 The 4^{th}. *equation*, by equall *Addition* and *Subtraction*, will be — $A = 5$

So it is manifest that the Asse or A carried 5 measures, and from the 3^{d}. and 5^{th}. it is also manifest that the Mule carried 7 measures.

Question 7. Two men were discoursing of their money in this manner, viz. A *saith to* B, *that* B *had three times as many pounds in his purse as* A, *and that if both their moneys were added together, the summe would be equall unto the Product when they were multiplyed one by the other; The question is, how many pounds each person had in his purse?*

1 Let the lesser number of *pounds* be — A

2 Then according to the question, the greater numb. of *pounds* is $3A$

3 The summe of both their *moneyes*; that is, of the first and second *equations* will be — $4A$

4 If both their *moneyes* be multiplied one by the other; that is if the first *equation* bee drawn into the second, the *Rectangle* will be — $3Aq$

5 But according to the question, the *Rectangle* is equall to the summe; therefore the 4^{th}. *equation* is equall to the 3^{d}. *viz.* $3Aq = 4A$

6 The 5^{th}. *equation* by depression will be — $3A = 4$

7 If both parts of the 6^{th}. bee applied to 3, it will be — $A = 1\frac{1}{3}$

By the last *equation* it is manifest that A or the person which had least mony, had $1\frac{1}{3}$ l. and consequently the other person had the triple thereof, which is 4 l. which numbers $1\frac{1}{3}$ and 4 being multiplied one by the other, will produce their sum which is $5\frac{1}{3}$. $5\frac{1}{3}$

Queſt. 8. *There are two numbers whoſe ſumme is* 10. *and if the greater be divided by the leſſe, the quotient will be* 20. *What are the Numbers?*

1	Let 10 (the *ſumme* of the 2 numbers) be——	B
2	Let 20 (the *quotient* propounded be——	C
3	Let the *greater number* ſought be——	A
4	It is manifeſt that if the *greater* of two numbers be *ſubtracted* from their ſumme, the remainder will be the leſſer; therefore the firſt *æquation* leſſe by the third is the *leſſer number*, viz.	$B - A$
5	If the third *æquation* be applied to the fourth, there will ariſe	$\frac{A}{B - A}$
6	According to the queſtion, if the *greater number* bee *divided* by the *leſſer*, the *quotient* muſt be 20; therefore the fifth *æquation* muſt be equall to the ſecond, *viz.* ——	$\frac{A}{B - A} = C$
7	The 6th. *æquation reduced*, will be ——	$A = CB - CA$
8	The 7th. by *tranſpoſition* of $- CA$ will be—	$A + CA = CB$

9	If both parts of the 8th. bee *applied* to $1 + C$ it will be——	$A = \frac{CB}{1 + C}$
10	The latter part of the 9th. being *reſolved* into *number*, it will be——	$A = 9\frac{11}{21}$

From the third and 10th. it is manifeſt, that the *greater number* ſought is $9\frac{11}{21}$, and from the firſt, fourth, and tenth; it is alſo manifeſt that the *leſſer number* is $\frac{10}{21}$, which two numbers will anſwer the conditions in the *queſtion.*

Queſtion 9. *Three men have each of them a certain number of pounds in his purſe, viz. the ſumme of the firſt and ſecond mans money is* 5 *pounds; the ſumme of the ſecond and third is twelve pounds, and the ſumme of the third and firſt is* 11 *pounds: The queſtion is, how many pounds each man hath.*

1	Let 5 the ſumme of the firſt and ſecond be ——	B
2	Let 12 the ſumme of the ſecond and third be——	C
3	Let 11 the ſumme of the third and firſt be ——	D
4	Let the firſt mans money be——	A
5	Let the ſecond mans money be——	E
6	Let the third mans money be——	I

7 Then according to the questions, the summe of the fourth and fifth *æquations* will be equal to the first, *viz.* — $A + E = B$

8 Also according to the question, the summe of the 5^{th}. and 6^{th}. *æquations* will be equall to the second, *viz.* — $E + I = C$

9 Also according to the question, the summe of the 6^{th}. and 4^{th}. *æquations* will be equall to the third, *viz.* — $I + A = D$

10 The sum of the 7^{th}. 8^{th}. and 9^{th}. will be — $2A + 2E + 2I = B + C + D$

11 If in stead of $2A + 2E$ in the 10^{th}. there be taken that wch is equall thereunto, *viz.* $2B$ (as is manifest by the 7^{th}.) it will be — $2B + 2I = B + C + D$

12 The 11^{th}. by equall *subtraction* of B, will be — $B + 2I = C + D$

13 The 12^{th}. by transposition of B, will be — $2I = C + D - B$

14 If both parts of the 13^{th}. be applied to 2, it will be — $I = \dfrac{C + D - B}{2}$

15 The latter part of the 14^{th}. being resolved into number, will be — $I = 9$

16 By the second, 8^{th}. and 15^{th}. it is manifest that — $E = 3$

17 By the third, 9 and 15^{th}. it is manifest that — $A = 2$

By the 4^{th}. 5^{th}. 6^{th}. and the 3 last *æquations* it is manifest that A or the *first man* had 2 pounds: E the second, 3 *pounds*; I the third, 9 *pounds*, which will answer the conditions in the *question*.

Question 10. *A Factor delivers 6 French Crowns and 2 Dollars for 45 shillings sterling; Also at another time he delivers 9 French*

Crowns and 5 Dollars (of the same Coin, and at the same rate with the former) for 76 shillings sterling; the question is to know the value of a French Crown; also of a dollar, in sterling money.

1	Let the 45 s. *sterling* mentioned in the question be —	B
2	Let the 76 s. *sterling* mentioned in the *question* be —	C
3	Let the value of a *French Crown* in *sterling money* be —	A
4	Let the value of a Dollar in *sterling money* be —	E
5	Then according to the *question*, 6 *Crowns* with 2 *dollars* are equall to 45 s. viz.	$6\ A + 2\ E = B$
6	Also according to the *question*, 9 *French Crowns* with 5 *dollars* are equall to 76 *shillings*, viz.	$9\ A + 5\ E = C$

7	The 5th. by transposition of $6\ A$, will be —	$2\ E = B - 6\ A$
8	If both parts of the 7th. be *applied* to 2 it will be —	$E = \frac{B - 6\ A}{2}$
9	If both parts of the 8th. be *drawn* into 5 it will be —	$5\ E = \frac{5B - 30\ A}{2}$
10	If in stead of $5\ E$ in the 6th. there be taken that which is equall thereunto, *viz.* the latter part of the 9th. the 6th. will be reduced into this.	$9\ A + \frac{5\ B - 30\ A}{2} = C$
11	The 10th. *æquation* reduced will be	$5\ B - 2\ C = 12\ A$

12	If both parts of the 11th. be applied to 12, it will be ——	$\frac{5B - 2C}{12} = A$
13	If the first part of the 12th. be resolved into number, it will be —	6 s. 1 d. $= A$.
14	By the first, 8th. and 13th. it is manifest that —	4 s. 3 d. $= E$.

By the 3d. 4th. 13th. and 14th. *equations*, it is manifest that a *French Crown* was equall unto 6 s. 1 d. and a *Dollar* equall unto 4 s. 3 d. which numbers will answer the conditions of the *Question*.

Question 11. *Three persons discourse of their money, in this manner;* viz. *The first saith to the other two, if* 100 *pounds be added to my money, the summe will be equall to both your moneyes; The second saith to the rest, if* 100 *pounds be added to my money, the summe will be equall to the double of both yours; The* 3d. *saith to the rest, if* 100 *pounds be added to mine, the summe will be equall to the triple of both yours: The question is how many pounds each person had.*

1 Let

1	Let 100 *pounds* mentioned in the *question* be ——	B
2	Let the first mans *money* be	A
3	Let the second mans *money* be	E
4	Let the third mans *money* be	I
5	Then according to the *question*, the sum of the first and second *equations* is equall to the sum of the 3d. and 4th. viz.	$B + A = E + I$
6	Also according to the *question*, the summe of the first and third is equall to the double of the sum of the 2d. and 4th. viz.	$B + E = 2A + 2I$
7	Also according to the *question*, the summe of the first and fourth is equall to the triple of the sum of the 2d. and 3d. *equations, viz.* ——	$B + I = 3A + 3E$

8 If

8 If the 2^{d}. *aequation* bee added to each part of the 5^{th}. it will be — $B + 2A = A + E + I$

9 The 8^{th}. by *transposition* of E, will be — $B + 2A - E = A + I$

10 If both parts of the 9^{th}. be drawn into 2, it will be $2B + 4A - 2E = 2A + 2I$

11 If instead of the latter part of the 6^{th}. there be taken that which is equall thereunto *viz*. the 1 part of the 10^{th}. the 6^{th}. will be reduced into this, viz. $B + E = 2B + 4A - 2E$

12 The eighth by *transposition* of I, will be — $B + 2A - I = A + E$

13 If each part of the twelfth bee drawn into 3, it will be — $3B + 6A - 3I = 3A + 3E$

14 If in stead of the latter part of the 7^{th}. there be taken that which is equall thereunto, *viz*. the first part of the 13^{th}. the 7^{th}. will be *reduced* into this — $B + I = 3B + 6A - 3I$

15 The 11^{th}. by equall *Addition* and *Subtraction*, will be — $3E = B + 4A$

16 If each part of the 15^{th}. be *applied* to 3, it will be $E = \frac{B + 4A}{3}$

17 The 14^{th}. by equall *Addition* & *Subtraction*, will be — $4I = 2B + 6A$

18 The 17^{th}. *applied* to 4, will be $I = \frac{2B + 6A}{4}$

19 The *summe*, of the 16^{th}. and 18^{th} will be — $E + I = \frac{5B + 17A}{6}$

20 If the 2^{d}. be added to each part of the 19^{th}. it will be — $A + E + I = \frac{23A + 5B}{6}$

21 If in stead of the first part of the 20^{th}. there bee taken that which is equall thereunto *viz.* the first part of the 8^{th}. the 20^{th}. will be *reduced* into this, *viz.* — $B + 2A = \frac{23A + 5B}{6}$

22 The 21^{th}. *reduced*, will be — $6B + 12A = 23A + 5B$

23 The 22^{th}. by equall *Subtraction* will be — $B = 11A$

24 If both parts of the 23^{th}. be *applied* to 11, it will be $\frac{B}{11} = A$

25 The 1 part of the 24^{th}. being *resolved* into *number* this will arise *viz.* — $9\frac{1}{11} = A$

26 From the first 16^{th}, and 25^{th}. it will be manifest that — $45\frac{5}{11} = E$

27 Also from the first 18^{th}. and 25^{th}. it will be manifest that — $63\frac{7}{11} = I$

By the 2^d. 3^d. 4^{th}. and the 3 last *Æquations* it is manifest that the first *Man* had $9\frac{1}{11}$ ℔. the 2^d. $45\frac{5}{11}$ ℔. and the 3^d. $63\frac{7}{11}$ ℔. which three numbers will answer the conditions in the *question.*

Question 12. *If* 100 *be given to be divided into* 4 *such parts, that the first part being increased with* 7, *the* 2^d. *part lessened by* 7, *the* 3^d. *part multiplied by* 7, *and the fourth part divided by* 7, *the summe, remainder, Product and Quotient may be equall between themselves, what will be the parts ?*

1 Let 100 (mentioned in the *question*) be — C

2 Let 7 (mentioned in the *question*) be — B

3 Let the 1. *part* be — A

4 Let the 2^d. *part* be — E

5 Let the 3^d. *part* be — I

6 Let the 4^{th}. *part* be — O

7 According to the *question*, if 7 be *added* to the 1. *part* and *subtracted* from the 2d. the *sum* and the *remainder* will be equall; therefore the *sum* of the 2d. and 3d. *æquations* is equall to the 4th. lesse by the 2d. *viz.* $B + A = E - B$

8 The 7th. *Æquation* by *transposition* of $-B$ will be —— $2B + A = E$

9 According to the *Question*, if the third *part* bee *multiplyed* by 7, the *Product* will be equall to the *summe* of 7, and the first *part*; therefore the *summe* of the second and third *æquations* will be equall to the *Rectangle* under the second and fifth, *viz.* $B + A = BI$

10 If both *parts* of the ninth be *applyed* to *B*, it will be — $\frac{B + A}{B} = I$

11 According

11 According to the *question*, if the fourth part be *divided* by 7, the *quotient* will be equall to the *summe* of 7, and the first *part*, therefore if the sixth *æquation* be *applied* to the second, the quotient will be equall to the *summe* of the second and third *æquations*, *viz.* ———— $B + A = \frac{O}{B}$

12 The 11th. *æquation reduced*, will be ——— $Bq + BA = O$

13 *Forasmuch as all the parts are equal to the whole*, therefore the *sum of the* 3d. *æquation*, together with the 1 parts of the 8th. 10th. and 12th, will bee equall to the first *Æquation*, *viz.* $\frac{2BA + 2Bq + A + B + BqA + Bc}{B} = C$

Ee 14 The

14 The 13^{th}. *reduced* will be-- $2BA + 2Bq + A + B + BqA + Bc = BC$

15 If the 14^{th}. be *resolved* into *numbers*, and the *numbers* added, it will be—— $64\,A + 448 = 700$

16 The 15^{th}. by *equall Subtraction* of 448 will be—— $64\,A = 252$

17 If both parts of the 16^{th}. be *applied* to 64, it will be—— $A = 3\,\frac{15}{16}$

18 By the 2^{d}. 8^{th}. and 17^{th}. it will be manifest that—— $E = 17\,\frac{15}{16}$

19 By the 2^{d}. 10^{th}. and 17^{th}. it will be manifest that—— $I = 1\,\frac{9}{16}$

20 By the 2^{d}. 12^{th}. and 17^{th}. it will be manifest that—— $O = 76\,\frac{9}{16}$

The latter parts of the 4 last *æquations* are the numbers sought, which will answer the conditions in the *question*.

Question 13. *Certain Noblemen being disposed to take their pleasure in a Progresse, carried with them a certain number of pounds*, viz. *every one as many pounds as the other, and so many Noblemen as there were, so many servants had each Nobleman to attend him; Also the number of pounds that each Nobleman carried was double the number of all the servants, and the summe of all their money was* 3456 *pounds: The question is, how many Noble men there were, also how many pounds each carried with him?*

1 Let 3456 (mentioned in the *question*) be —— B

2 Let the number of *Noblemen* be A

3 Then according to the *question*, the number of *servants* attending each *Nobleman* will be also —— A

4 It is also manifest that if the second *æquation* bee *drawn* into the third, it gives the number of all the *servants*, *viz*. —— Aq

5 And since by the question, the double of the number of *servants* was the number of *pounds* which each *Nobleman* had: therefore the fourth *æquation drawn* into 2 gives the said number of *pounds*, *viz*. $2\,Aq$

6 It is also manifest, that if the second *æquation* bee *drawn* into the 5^{th}. the rectangle will be the sum of *pounds* which all the *Noblemen* had, *viz*. —— $2\,Ac$

7 But by the first *æquation* it is manifest, that the summe of *pounds* which all the *Noblemen* had, was B, which must be equall to the 6^{th}. *æquation*, *viz*. —— $2\,Ac = B$

8 The

8 8 The 7th. *æquation* being *applyed* to 2 it will be —— $Ac = \frac{B}{2}$

9 The *Cube root* of $\frac{B}{2}$ that is, of 1728 being *extracted*, it will be $A = 12$

From the 2d. 3d. 5th. and 9th. *æquations* it is manifest that there were 12 *Noblemen*, and each had 288 *pounds*; Also each *Nobleman* had 12 *servants* to attend him.

Question 14. *If 4050 Souldiers are to bee set in battell in a rectangular Figure, in such manner that the number in File may be to the number in ranke as 1 to 2, how many Souldiers are to be placed in Ranke, and how many in File? Or which is the same in effect, a Rectangle together with the proportion of the sides is given to find the sides.*

1 Let 4050 or the *Rectangle* be —— B

2 Let (1) the *lesser term* of the *Proportion* be —— R

3 Let (2) the *greater terme* of the *Proportion* be —— S

4 Let the *lesser side* unknown, or the number of men to be placed in *File* be —— A

5 Then

5 Then according to the *question*, As 1 is to 2, so is the number in *File* to the number in *Ranke*; therefore $R . S :: A . \frac{SA}{R}$ so the number to be set in *Rank* or the *greater side* will be —— $\frac{SA}{R}$

6 *Multiply* the *lesser side* by the *greater*, viz. *draw* the fourth *æquation* into the fifth, so will the Product be —— $\frac{SAq}{R}$

7 Since the *Factus* or *Product* of 2 sides is equall to the *Rectangle* made of them, therefore the sixth *Æquation* is equall to the first, *viz.* —— $\frac{SAq}{R} = B$

8 The seventh *æquation* reduced is —— $SAq = RB$

9 If both parts of the seventh be applied to S it will be —— $Aq = \frac{RB}{S}$

10 The ninth reduced into proportionalls will be —— $S.R :: B.Aq$

The 10th. æquation in words is the following Theoreme, viz. *As the greater term of the proportion given is to the lesser, so is the number of men to be set in battell, (or the Rectangle) to the square of the lesser side (whether it be Ranke or File) and consequently the square root of the said fourth proportionall is the lesser side; If the*

 greater

greater side had been A, then the Theoreme would have been as followeth.

As the lesser term of the proportion given is to the greater: so is the Rectangle (or number of men to be set in battell) to the square of the greater side (whether it be Ranke or File) and consequently the square root of the said fourth proportionall is the greater side.

Illustration.

The 10th. Æquation resolved into numbers will be as followeth.

1\. *As* 2 — 1 — 4050 (2025 (45 *Men in File*

2\. *As* 1 — 2 — 4050 (8100 (90 *Men in Rank*

The proofe — 4050

Or when one of the sides is found by the preceding *Theoreme*, the other may bee found by *Division*, viz.

$$\frac{4050}{45} = 90 \text{ Or } \frac{4050}{90} = 45$$

Question 15. *There are three numbers in Geometricall proportion continued,* viz. *the mean proportionall is* 24, *and the sum of the extremes is* 80, *what are the extremes?*

1	Let 24, (the *mean proportionall*) be ——	B
2	Let 80 (the *sum* of the *extremes*) *be* ——	C
3	Let the *lesser extreme* be ——	A
4	Then subtracting the *lesser extreme* from the summe of the *extremes*, *viz.* the third *æquation* from the second, the remainder will be the greater *extreme*, *viz.*	$C - A$
5	The *Product* of the *extremes*, (*viz.* the third *Æquation drawn* into the fourth) is ——	$CA - Aq$
6	By 20 è 7 *Euclid. Elem.* the 5th. *æquation* is equall to the square of the first, *viz.* ——	$CA - Aq = Bq$

Wherefore by *Rule* I. in *pag.* 387 it will be as followeth, *viz.* ——

$$\frac{C}{2} - \sqrt{u}: \frac{Cq}{4} - Bq: = A \text{ the lesser extreme}$$

$$\frac{C}{2} + \sqrt{u}: \frac{Cq}{4} - Bq: = A \text{ the greater extreme}$$

Which Theoreme in words will bee thus expressed, viz.

If half the summe of the extremes be lessened by the Square root of the remainder found by subtracting the Square of the meane from $\frac{1}{4}$ of the Square of the summe of the extremes, it gives the lesser extreme : Or half the summe of the extremes increased with the Square root of the remainder found, &c. gives the greater extreme.

By which *Theoreme*, the *extremes* will bee found 8, and 72, so that the numbers 8. 24. 72. are continuall proportionalls, the Mean being 24 and the summe of the extremes 80, as was propounded.

Question 16. *A Merchant buyes clothes, and selleth them at* 17 $\frac{1}{4}$ ℔. *the piece, and gaineth in* 100 ℔. *as many pounds as he paid for one piece ; the question is what he paid for a Cloth ?*

1	Let 100 ℔. mentioned in the question be ——	B
2	Let 17 $\frac{1}{4}$ ℔. mentioned in the question be ——	C
3	Let the gaine of one Cloth be——	A
4	Then subtracting the gain of a Cloth from all the money received for a Cloth, the remainder will bee the *first cost* of a Cloth, *viz.* the 2^d^. *equation* lesse by the 3^d^. is ——	$C - A$

5	Again, as the *first cost* of a Cloth is to the gain thereof, so is 100 ℔. to the gain thereof, *viz.* $C - A . A :: B . \frac{BA}{C-A}$. so the gain of 100 ℔. will be —	$\frac{BA}{C-A}$
6	According to the question, the gain of 100 ℔. was equall to the *first cost* of a *Cloth*, therefore the 5^th^. *equation* will bee equall to the 4^th^. *viz.*	$\frac{BA}{C-A} = C - A$
7	The 6^th^. *equation reduced*, will be ——	$BA = Cq - 2CA \dotplus Aq$
8	The 7^th^. by *transposition*, will be——	$BA \dotplus 2CA - Aq = Cq$

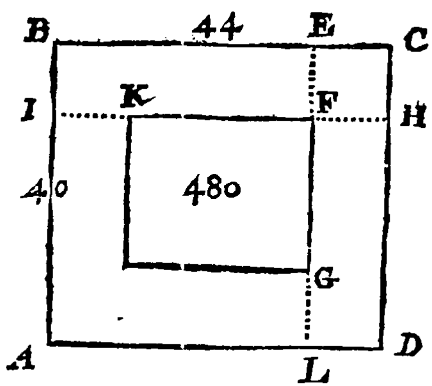
And by *Rule* I. in *pag.* 387 it will be as followeth :

$$\frac{B \dotplus 2C}{2} - \sqrt{u} : \frac{Bq \dotplus 4CB \dotplus 4Cq}{4} - Cq : = A$$

By which *Theoreme* the *gain* of a *Cloth* will be found 2 $\frac{1}{4}$ ℔. which being subtracted from 17 $\frac{1}{4}$ ℔. (the price for which a *Cloth* was sold) leaves 15 ℔. for the *first cost* of a *Cloth*, as will be manifest by the following proportion.

15 —— 2 $\frac{1}{4}$ —— 100 —— (15

Question 17. *A certain Nobleman intending to make a Garden of pleasure, gives directions to a Surveyor to lay forth* 11 *Acres in a long Square, whose length may be* 44 *poles, and breadth* 40 *poles; Moreover, he desires to have* 3 *Acres in a pond, to lie in another long Square within the former, and in such manner that there may be one and the same parallell distance between the sides of the long Squares: The question is to know the length and breadth of the pond, also the said Parrallell distance?*



1 Let BC or AD (44) the *length* of the greater *long square* be — B

2 Let BA or CD (40) the *breadth* of the same *long square* be — C

3 Let

3 Let the *Area* of the *pond* or interiour long square, *viz.* 3 *Acres*, or 480 *Perches* be — D

4 Let the parrallell distance EF, or HF be — A

5 Then it is manifest that the length of the interiour long square, *viz.* KF, is equall to IH or BC, lesse by the double of the parrallell distance HF, therefore the first *æquation* lesse by the double of the fourth is the length of the interiour long square, *viz.* — $B - 2A$

6 It is also manifest that the breadth of the interiour long square *viz.* FG is equall to EL or CD lesse by the double of the Parrallell distance EF, therefore the 2d. *æquation* lesse by the double of the fourth, is the breadth of the interiour long square *viz.* $C - 2A$

7 The rectangle under the fifth and sixth *Æquations*, is — $BC - 2BA - 2CA + 4Aq$

8 The

8 The 7th. *Æquation* being the *Area* of the interiour long square is equall to the third, *viz.*

$$BC - 2BA - 2CA + 4Aq = D$$

9 The 8th. by *transposition* will give this —

$$BC - D = 2BA + 2CA - 4Aq$$

10 If both parts of the ninth be applied to 4 it will be —

$$\frac{BC - D}{4} = \frac{BA + CA}{2} - Aq$$

11 And by *Rule* I. in *page* 387 it will be as followeth;

$$\frac{B + C}{4} - \text{ſ}u : \frac{Bq - 2BC + Cq + 4D}{16} := A$$

Which Theoreme will be thus expressed in words, viz.

If $\frac{1}{4}$ *of the summe of the length and breadth of the greater long square be lessened by the square root of* $\frac{1}{16}$ *of the Aggregate of the quadruple Area of the interiour long square, and the square of the difference between the length and breadth of the greater long square, it gives the parrallell distance between them.*

12 By the aforesaid *Theoreme* the parrallell distance will be found — 10

13 Also from the first, fifth, and twelfth it will be manifest that *FK* the length of the interiour long-square is — 24

14 And from the second, sixth, and twelfth it will be manifest that *FG* the breadth of the interiour long square is — 20

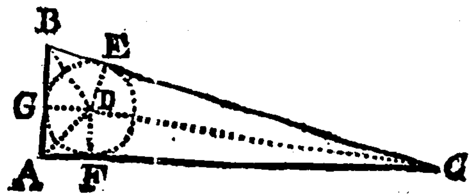
15 Lastly, the Product of the thirteenth and fourteenth is the *Area* of the interiour long square or pond, *viz.* 480

Question, 18. *There is a right-angled Triangle ABC whose Area is* 40, *and the Perimeter or summe of all the* 3 *sides is also* 40, *what are the sides?*

Preparation

Preparation.

Vid. Briggi Arith. Logarith. Cap. 15. Sect. 8.



In any plain Triangle, the Semi-perimeter multiplyed by the Semidiameter of the Inscribed Circle produceth the Area of the Triangle, and consequently if the Area be divided by the Semi-perimeter, the Quotient will be the Semidiameter of the inscribed Circle: So in the aforesaid *Triangle* it is manifest that if DE (the *Semidiameter* of the *Inscribed Circle*) be multiplyed by the half of BC, the Product will be the *Area* of the *Triangle* DBC; Also DF multiplyed by $\frac{1}{2}$ of AC produceth the *Area* of the *Triangle* ADC; and DG multiplyed by $\frac{1}{2}$ of AB produceth the *Area* of the *Triangle* BDA; which three *Triangles* are equall to the *Triangle* ABC.

Moreover,

Moreover, by the aforesaid Diagram it will be manifest, that in any right-angled plain Triangle, the Diameter of the inscribed Circle is equall to the difference between the Hypothenusall and the summe of the sides containing the right angle, For $CF = CE$ and $BG = BE$, therefore $CF + BG = BC$. Also it is manifest if $CF + BG$ ($= BC$ the *Hypothenusall*) be subtracted from $CA + BA$ (the *summe* of the *containing sides*) the remainder will bee $FA + GA = DG + DF =$ the *Diameter* of the *Inscribed Circle*; which *premisses* being observed, the *Hypothenusall* of the aforesaid *Triangle* will be found 18, and the *summe* of the *containing sides*, 22. For if 40 the *Area* of the *Triangle* be divided by the *Semiperimeter* 20, the qnotient will be 2 for the *Semidiameter* of the Inscribed Circle; therefore the *Diameter* is 4, which being subtracted from the *Perimeter* 40, the remainder is 36, whose halfe is 18 for the *Hypothenusal* BC, which subtracted from 40 the Perimeter, leaves 22 for the *summe* of the *containing sides*, then proceed to find the said *sides* as followeth, *viz*.

1	Let BC (18) the *Hypothenusal* be	B
2	Let 22 the *summe* of the containing sides AC, AB, be —	C
3	Let one of the containing sides be ——	A

4 Then

4 Then it is manifest that the second *æquation* lesse by the third is the other containing side, *viz.* $\} \; C - A$

5 The square of the first *æquation* is —— $\} \; Bq$

6 The square of the third is — $> \; Aq$

7 The square of the fourth is —— $\} \; Cq - 2\,CA + Aq$

8 The *summe* of the sixth and seventh is — $\} \; Cq - 2\,CA + 2\,Aq$

9 By 47 è 1 *Euclid. Elem.* the eighth *æquation* is equall to the fifth, *viz.* $\} \; Cq - 2\,CA + 2\,Aq = Bq$

10 The ninth by *transposition*, will be — $\} \; Cq - Bq = 2CA - 2\,Aq$

11 If both parts of the tenth bee *applyed* to 2 it will be — $\} \; \dfrac{Cq - Bq}{2} = CA - Aq$

12 And by *Rule* I. in *page* 387 it will be as followeth:

½C.

$$\tfrac{1}{2}C + \sqrt{u} : \frac{2\,Bq - Cq}{4} : = A \text{ (the greater side)}$$

$$\tfrac{1}{2}C - \sqrt{u} : \frac{2\,Bq - Cq}{4} : = C - A \text{ (the lesser side)}$$

Which Theoreme will bee thus expressed in words, viz. *If halfe the summe of the containing sides of a right angled plain Triangle, be increased with the square root of* $\frac{1}{4}$ *of the remainder found by subtracting the square of the said summe from twice the square of the Hypothenusal, the Aggregate will be the greater containing side; Or if half the summe of the containing sides be lessened by the square root of* $\frac{1}{4}$ *of the remainder found, &c. it leaves the lesser containing side.*

By which Theoreme, the greater containing side of the aforesaid Triangle will bee found $11 + \sqrt{41}$. or 17.403124 &c. and the lesser containing side will bee found $11 - \sqrt{41}$ or 4.596875, &c.

Ff *Illustration*

Illustration Arithmeticall.

The Hypothenusal BC —	18
The Base AC —	17.403124, &c.
The Perpendicular AB —	4.596875, &c.
The Perimeter —	39.999999

The Base AC —	17.403124, &c.
Half the Perpendicular AB —	2.298437, &c.
The Area —	39.9999, &c.

Whereby it is manifest, that the *Area* of the aforesaid *Triangle* is equall to the *Perimeter*, as was propounded.

Question 19. *The Hypothenusal and Area of a right angled Triangle being known, to find the sides.*

1 Let the *Hypothenusal* be — H

2 Let the *Area* be — C

3 Since the double *Area* is equall to the *Rectangle* under the *Base* and *Perpendicular*; therefore the Rectangle under the Base and Perpendicular is — $2C$

4 Let one of the sides containing the right angle be — A

5 It is manifest that the Rectangle or Product of two numbers being divided by one of them, the Quotient will bee the other; therefore if the third *æquation* be applied to the fourth, the Quotient will be the other containing side of the Triangle, *viz.* $\dfrac{2C}{A}$

6 The square of the first *æquation* is — Hq

7 The square of the fourth *æquation* is — Aq

8 The square of the fifth *æquation* is — $\dfrac{4Cq}{Aq}$

9 The summe of the 7th and 8th *æquations* is — $\dfrac{Aqq + 4Cq}{Aq}$:

10 By the 47 è 1 *Euclid. Elem.* the 8th. *æquation* is equall to the 6th. *viz.* — $\dfrac{Aqq + 4Cq}{Aq} = Hq$

11 The 10th. *æquation* reduced is — $Aqq + 4Cq = Hq\,Aq$

12 The 11th. by transposition of *Aqq* will be — $4Cq = Hq\,Aq - Aqq$

13 And by Rule I. in *page* 387 it will bee as followeth. —

$$\frac{Hq}{2} + \sqrt{u}:\frac{Hqq}{4} - 4Cq: = Aq$$ *the ſquare of the greater ſide.*

$$\frac{Hq}{2} - \sqrt{u}:\frac{Hqq}{4} - 4Cq: = \frac{4Cq}{Aq}$$ *the ſquare of the leſſer ſide.*

Which Theoreme will be thus expreſſed in words, viz.

If half the ſquare of the Hypothenuſall be increaſed with the ſquare root of the remainder found by ſubtracting the quadruple of the ſquare of the Area from $\frac{1}{4}$ *of the Biquadrate of the Hypothenuſal, it gives the ſquare of the greater containing ſide, and conſequently the ſquare root of the ſaid aggregate is the ſaid containing ſide: Or if half the ſquare of the Hypothen. be leſſened by the ſquare root of the remainder found,* &c. *it gives the ſquare of the leſſer containing ſide; and conſequently the ſquare root of the laſt remainder is the leſſer containing ſide: So if the Hypothenuſal be 5 and the Area 6 the greater containing ſide will be found (by the aforeſaid Theoreme) to be 4, and the leſſer containing ſide 3.*

Queſtion 20. *There are 3 numbers in Geometricall proportion continued, the mean proportionall being 24, and the difference of the extremes is 140, What are the extremes?*

1 Let

1	Let the mean proportionall be —	B
2	Let 140 the difference of the extremes be —	C
3	Let the leſſer extreme be —	A
4	Then if the difference of the extremes be added to the leſſer extreme, the ſumme will be the greater extreme; therefore the ſumme of the ſecond and third *æquations* is the greater extreme, *viz.* —	$C + A$
5	The Rectangle under the extremes, *viz.* the third *æquation* drawn into the fourth is	$CA + Aq$
6	By 20 è 7. *Euclid. Elem.* the 5th. *æquation* is equall to the ſquare of the firſt, *viz.*	$CA + Aq = Bq$

Wherefore by Rule II. in *page* 388 it will be as followeth:

$$\sqrt{u}:\frac{Cq}{4} + Bq: - \frac{C}{2} = A$$

Which Theoreme in words, will be thus expreſſed, viz.

If the ſquare root of the ſumme of $\frac{1}{4}$ *of the ſquare of the difference of the extremes, and the*

 ſquare

square of the mean proportionall be lessened by half the difference of the extremes, the remainder will be the lesser extreme.

So by the said *Theoreme* there will be found 4 for the lesser extreme, which added to 140 (the difference of the extremes) gives 144 for the greater extreme; and therefore the numbers 4. 24. 144. are continuall proportionalls, the mean proportionall being 24, and the difference of the extremes 140 as was propounded.

Question 21. *A Factor buyeth certain pieces of Sattins and Tafferies in such sort that a yard of Sattin cost more then an Ell of Taffety; also 2 yards of Sattin together with three Ells of Taffety cost 51 shillings, and the difference between the squares of the price of a yard of the one, and of an Ell of the other was 176 s. The question is to know the price of a yard of Sattin; also of an Ell of Taffety?*

1 Let the 51 s. mentioned in the question be — B

2 Let the 2 yards of Sattin be — C

3 Let the 3 Ells of Taffety be — D

4 Let the 176 s. mentioned in the question be — G

5 Let the price of a yard of Sattin be — A

6 Let the price of an Ell of Taffety be — E

7 If (according to the question) the second *Æquation* be drawn into the fifth, it gives the price of 2 yards of Sattin, *viz.* — CA

8 Also according to the question, if the third æquation be drawn into the sixth, it gives the price of 3 Ells of Taffety, *viz.* — DE

9 The fifth æquation squared, is the square of the price of a yard of Sattin, viz. — Aq

10 The sixth æquation squared, is the square of the price of an Ell of Taffety, viz. — Eq

11 Since a yard of Sattin cost more then an Ell of Taffety, the ninth æquation lesse by the tenth will bee the difference of the squares of the price of a yard of the one, and of an Ell of the other, viz. — $Aq - Eq$

12 According to the question, the difference of the squares of the price of a yard of the one, and of an Ell of the other is 176; therefore the 11th. is equal to the 4th. viz. $Aq - Eq = G$

13 Also according to the question, the summe of the seventh and eighth æquations will be equall to the first, viz. $CA + DE = B$

14 The thirteenth æquation by transposition of CA, will be — $DE = B - CA$

15 If both parts of the fourteenth bee applyed to D it will be — $E = \frac{B - CA}{D}$

16 The square of the 15th. will be — $Eq = \frac{Bq - 2\,BCA + Cq\,Aq}{Dq}$

17 If in stead of Eq in the 12th. you take that wch is equal unto it, viz. the latter part of the 16th. this æquation wil arise, viz. $Aq - \frac{Bq - 2BC\,A + Cq\,Aq}{Dq} = G$

18. The

18 The 17th. reduced will be $AqDq - Bq + 2BC\,A - Cq\,Aq = DqG$

19 The 18th. by transposition of $-Bq$ will be $AqDq + 2BC\,A - Cq\,Aq = DqG + Bq$

20 If both parts of the 19th. be applied to $Dq - Cq$, it will be $Aq + \frac{2BCA}{Dq - Cq} = \frac{DqG + Bq}{Dq - Cq}$

21 If the known quantities of the twentieth bee resolved into numbers it will be — $Aq - \frac{204}{5}A = 837$

22 And

22 And by the *Rule* II. in *page* 388 the price of a yard of Sattin will bee found 15 s. *viz.* $\Big\} \surd u\!: \frac{10404}{25} + 837 : - \frac{102}{5} = A = 15$

23 Also from the first, second, third, sixth, 15th. and 22th. *æquations* the price of an Ell of Taffety will bee found 7 s. *viz.* —— $\Big\}\ E = 7$

Question 22. *In a right angled plain Triangle, there being given the Base together with the Product of the Hypothenusal and Perpendicular, to finde the Hypothenusal and Perpendicular;*

1 Let the Base be —————— $> B$

2 Let the Product of the Hypothenusal and Perpendicular be — $\Big\}\ C$

3 Let the Perpendicular be —— $> A$

4 It is manifest that if the Product of 2 numbers be divided by one of them, the quotient will bee the other, therefore if the 2d. *æquatiō* be *applied* to the 3d. the *quotient* will be the *Hypothenusal*, *viz.* $\Big\}\ \frac{C}{A}$

5 The

5 The square of the *Hypothenusal* viz. of the 4th. *æquation* is —— $\Big\}\ \frac{Cq}{Aq}$

6 The square of the *Base*, viz. of the first *æquation* is — $\Big\}\ Bq$

7 The square of the *Perpendicular*, viz. of the 3d. *æquation* is —— $\Big\}\ Aq$

8 The summe of the 6th. and 7th. *æquations* is —— $\Big\}\ Bq + Aq$

9 By the 47 è 1. *Euclid. Elem.* the 8th. *æquation* is equall to the 5th. *viz.* —— $\Big\}\ Bq + Aq = \frac{Cq}{Aq}$

10 The 9th. *æquation* reduced, will be — $\Big\}\ Bq\,Aq + Aqq = Cq$

And by *Rule* II. in *page* 388 it will bee as followeth, *viz.*

$$\surd u\!: \frac{Bqq}{4} + Cq : - \frac{Bq}{2} = Aq$$

Which Theoreme will bee thus expressed in words, viz.

If the square root of the summe of $\frac{1}{4}$ *of the Biquadrate of the Base, and the square of the Product of the Hypothenusal and Perpendicular, be lessened by half the square of the Base, the remainder will be the square of the Perpendicular, and consequently the square root of the said remainder will be the Perpendicular.*

So

So if the Base bee 3, and the Product of the Hypothenusal and Perpendicular bee 20, the Perpendicular will be found (by the aforesaid Theoreme) to be 4. Lastly, the Base and Perpendicular being known, the Hypothenusal will be found (by the 47 è 1 *Euclid. Elem.*) to be 5.

Question 23. *A Merchant buyes two sorts of linnen cloth*, viz. 90 *Ells of one sort together, with* 40 *Ells of a worser sort for* 42 ℔. *and he finds that in laying forth* 1 *pound upon each sort he hath* $\frac{1}{3}$ *of a yard more of the worser sort then of the other; The question is what a yard of each sort did cost?*

1 Let the 90 Ells of the better sort be — B

2 Let the 40 Ells of the worser sort be — C

3 Let 42 ℔. the full cost of both sorts be — D

4 Let the number of Ells of the better sort bought for 1 ℔. be — A

5 Then according to the question, the number of Ells of the worser sort bought for 1 lb. will be — $A + \frac{1}{3}$

6 Find the full cost of the worser sort, viz. say, $A + \frac{1}{3}$. 1 : : C. $\frac{3C}{3A+1}$ So the full cost will be — $\frac{3C}{3A+1}$

7 Find the full cost of the better sort, viz. say, A. 1 : : B. $\frac{B}{A}$

8 So the full cost will be — $\frac{B}{A}$

The sum of the sixth and seventh *Æquations* is the full cost of both sorts, $\frac{3CA + 3BA + B}{3Aq + A}$

9 According to the question, the full cost of both sorts, was 42 ℔. or D. therefore the 8th. *æquation* is equall to the 3d. *viz.* $\frac{3CA + 3BA + B}{3Aq + A} = D$

10 The ninth *æquation* reduced is — $3CA + 3BA + B = 3DAq + DA$

11 The tenth by transposition of $3CA + 3BA$ will be — $B = 3DAq + DA - 3CA - 3BA$

12 If both parts of the eleventh bee applied to $3D$ it will be $\frac{B}{3D} = Aq + \frac{DA - 3CA - 3BA}{3D}$

13 The 12^{th}. being resolved into number and reduced will be — $Aq - \frac{58}{21}A = \frac{5}{7}$

14 Wherefore by *Rule* III. in *page* 389 it will be — $\frac{29}{21} + \surd\frac{1156}{441} = A = 3$

By the fourth and 14^{th}. *æquations* it is manifest that the number of Ells bought for 1 ℔. of the better sort was 3, and consequently by the question, the number of Ells of the worser sort bought for 1 ℔. was $3\frac{1}{3}$, whence by the *Rule* of 3 it will be manifest that 1 Ell of the better sort did cost 6 s. 8 d. and 1 Ell of the worser sort, 6 s. which two prices will answer the conditions in the question.

Question 24. *Two Merchants*, viz. A *and* B. *enter into company*, A *puts in a summe of money for* 3 *moneths, and* B *puts in* 50 ℔. *more then* A *for* 5 *moneths; they gain together* 140 ℔. *whereof* A *takes so much that if* 60 ℔. *be added to it, the*

the sum will be equall to the stock wherewith he entred company; The question is, what was the stock and gain of each Merchant?

1 Let 3 (the number of moneths belonging to the first Merchants stock) be — B

2 Let 50 ℔. (the difference of their stocks be) — C

3 Let 5 (the number of moneths belonging to the second Merchants stock) be — D

4 Let 140 ℔. (the totall gain) be — F

5 Let 60 ℔. (the difference between the first Merchants stock and his gain) be — G

6 Let the stock of the first Merchant be — A

7 Then will the summe of the second and sixth *æquations* bee the second Merchants stock, *viz.* — $C + A$

8 The Rectangle of the first and sixth *æquations* is the Product of the first Merchants stock multiplied by his time, *viz.* — BA

9 The Rectangle of the third and seventh *æquations* is the Product of the second Merchants stocke multiplied by his time, *viz.* — $DC + DA$

10 Since

10 Since (according to the *Rule* of *Fellowship*) the sum of the eighth and ninth *aequations* is in such proportion to the eighth as the fourth *aequation* is to the gain of the first Merchant, *viz.* $DC+DA+BA \,.\, BA :: F \,.\, \frac{FBA}{DC+DA+BA}$ therefore the gain of the first Merchant is — $\frac{FBA}{DC+DA+BA}$

11 The summe of the fifth and tenth *aequations* is $\frac{FBA+GDC+GDA+GBA}{DC+DA+BA}$

12 According to the question the 11th. must bee equall to the 6th. viz. $\frac{FBA+GDC+GDA+GBA}{DC+DA+BA}=A$

13 The 12th. reduced will be $FBA+GDC+GDA+GBA=DCA+DAq+BAq$

14 The

14 The 13. by *transpositiõ* will be $DAq+BA+DCA-FBA-GDA-GBA=GDC$

15 If both sides of the 13th. be *applied* to $D+B$ it will be — $Aq+\frac{DCA-FBA-GDA-GBA}{D+B}=\frac{GDC}{D+B}$

16 The 15th. resolved into numbers will be — $Aq-81\frac{1}{4}A=1875$

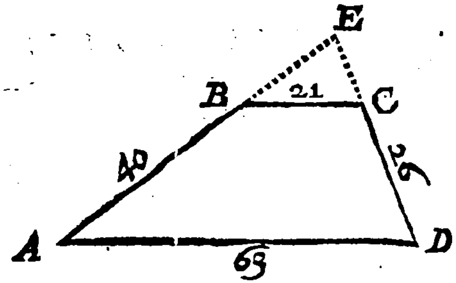
Wherefore by *Rule* III. in *page* 389 the value of *A* or the first *Merchants stocke*, will bee found 100 lb. unto which if 50 lb. be added, the summe will be 150 lb. for the stock of the second *Merchant*, then working as in the *Rule* of *Fellowship* with time, the gain of the first *Merchant* will be found 40 lib. and the gain of the other will be found 100 lib. which numbers will answer the conditions in the question.

Question 25. *There is a Trapezium* A B C D *which hath two parallel sides*, viz. A D and B C.

 and

and all the foure sides are knowne, viz. AB, 40 | BC 21. | CD, 26 | *and* AD. 63. *The question is to know the superficiall Content or Area of the Trapezium.*

Preparation.



If the sides *AB*, *DC* be continued untill they meet in the point *E*, there will be two *equiangled Triangles*, *viz.* *EBC*, *EAD*, whose sides are proportionall by 4 è 6 *Euclid.* It is also manifest that if the *Area* of the *Triangle EBC* be subtracted from the *Area* of the *Triangle EAD*, the remainder will be the *Area* of the *Trapezium ABCD*, which premisses being observed, the *Analysis* will be as followeth, *viz.*

1 Let

1 | Let *AB*. (40) be —— > *B*

2 | Let *BC* (21) be —— > *C*

3 | Let *CD* (26) be —— > *D*

4 | Let *AD* (63) be —— > *F*

5 | Let the *continuation BE* be —— > *A*

6 | Find a fourth *proportionall* unto the sides *EB*, *BC*, *EA*, viz. respect being had unto the *Symbols*, it will bee $A . C :: A \div B . \frac{CA \div CB}{A}$ So the fourth proportionall is —— > $\frac{CA \div CB}{A}$

7 | Forasmuch as the *triangles EBC*, *EAD* are equiangled; therefore the sixth *Æquation* must be equall to the fourth, *viz.* $\frac{CA \div CB}{A} = F$

8 | The seventh *reduced*, will be —— $CA \div CB = FA$

9 | The eighth by *transposition* of *CA* will be —— $CB = FA - CA$

10 | If both parts of the eighth be *applyed* to *F-C* it will be —— $\frac{CB}{F-C} = A$

11 | The tenth *reduced* into *proportionals* will be —— $F-C . C :: B . A$

12 | The 11th. in words is the following *Theoreme*, viz.

 As

As the difference between the lengths of the parallel sides is to the shorter parallel; so is the greater of the two sides which are not parallels, to the continuation thereof to meet with the lesser side which is not parallel: Or so is the lesser side to the lesser continuation.

13 By the said *Theoreme*, the *continuation* B E will be found 20, also the *continuation* CE will be found 13, and consequently the side EA is 60, and ED, 39.

14 By the 3 sides EA, AD, ED, the *Area* of the *triangle* EAD will be found —— 1134

15 Also by the 3 sides EB, BC, EC the *area* of the *triangle* EBC will be found —— 126

16 Lastly, if the *area* of the *triangle* EBC be subtracted from the *area* of the *triangle* EAD, the remainder wil be the *area* of the *Trapezium* ABCD *viz.* —— 1008

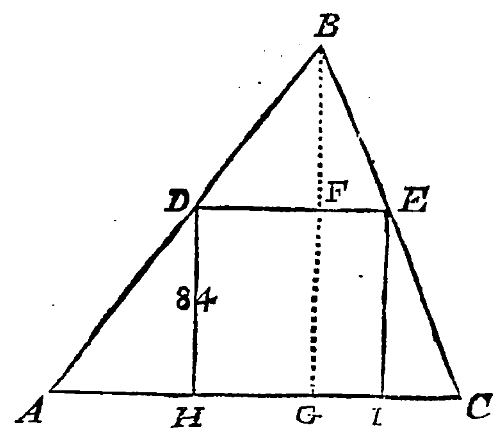
Question 26. *There is a Triangle* ABC *whose sides are known,* viz. AB, 195 | AC, 182 | BC, 169. *Within which Triangle there is a square inscribed*, viz. HDEI: *The question is to know the side of said square*, viz. DE *or* DH?

Preparation.

Preparation.

Let fall the *Perpendicular* BG, then will the *triangles* BFD, BGA be equiangled, also BFE, BGC are equiangled (by 29 è 1 *Euclid.*) therefore their sides will be proportionall (by 4 è 6 *Euclid.*) from whence these proportions will arise, *viz.*

BF . FD :: BG . GA
BF . FE :: BG . GC
2 BF . FD + FE :: 2 BG . GA + GC.
BF . FD + FE :: BG . GA + GC



Whence it is manifest that BF . DE :: BG . AC which being laid as a ground, the *Analysis* will be as followeth, *viz.*

 1 Let

1 Let AC, (182) be———— B

2 Let BG, 156 (found by the three sides $AB, AC. CB$) be—— C

3 Let DE or FG the side of the *inscribed square* be—— A

4 It is manifest that BF is the difference between BG and FG; therefore the second *æquation* lesse by the third, is equall to BF which is———— $C-A$

5 Find a fourth proportionall unto BF, DE, BG, *viz.* respect being had unto the *Symbols*, it will bee $C-A.\ A :: C.\ \frac{C\ A}{C-A}$ So is the fourth Proportionall found to be $\frac{C\ A}{C-A}$

6 From the *Proportions* first *demonstrared* it is manifest, that the fifth *æquation* must bee equall to the first, *viz.*—— $\frac{C\ A}{C-A} = B$

7 The sixth *æquation* reduced will be—— $CA = BC-BA$

8 The seventh by *transposition* of $-BA$ will be $CA + BA = BC$

9 If both parts of the 8^{th}, bee *applyed* to $C+B$ it will be —— $A = \frac{B\ C}{C+B}$

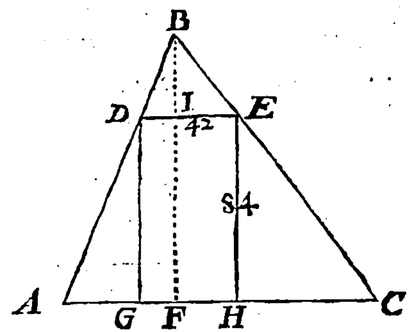
10 The

10 The ninth reduced into *Proportionals* will be $C+B.\ B :: C.\ A$

The 10th. *in words is the following Theoreme, viz.* *As the summe of the Base and perpendicular, is to the Base; so is the perpendicular to the side of the inscribed square.*

By which *Theoreme*, the side DE or DH will be found 84.

Question 27. *There is a Triangle* ABC, *whose sides are known,viz.* AC. 140 | AB. 130 | *and* BC 150, *within which Triangle it is required to inscribe a long square; whose length may be to the breadth in any proportion assigned, viz. as* 2 *to* 1, *the question is to know the length and breadth of the said inscribed long square?*



1 Let AC, 140 be ———— B

2 Let BF, 120. (found by the 3 sides AB, BC, and AC.) be—— C

3 Let

3 Let 1. the *lesser terme* of the *proportion* assigned be —— } R

4 Let 2. the *greater terme* of the *proportion* be —— } S

5 Let *DE* or *GH*, the *breadth* of the *long square* be —— } A

6 Since the *breadth* is to the *length* as 1 to 2, *viz.* $R . S : : A . \frac{SA}{R}$ therefore *DG* or *IF* the length of the *long square* is equall unto —— } $\frac{SA}{R}$

7 It is manifest that *BI* is the *difference* between *BF* and *IF*; therefore the 2d. *æquation* lesse by the 6th. is equall to *BI* which is —— } $\frac{CR-SA}{R}$

8 By the *Preparation* unto the 26 *Question*, it is manifest that *BI. DE : : BF. AC.* therefore find a fourth *proportionall* unto *BI. DE. BF. viz.* respect being had unto the *Symbols*, it will bee $\frac{CR-SA}{R} . A : : C . \frac{RCA}{CR-SA}$ So the fourth *proportionall* is —— } $\frac{RCA}{CR-SA}$

9 By

9 By the afore mentioned Preparation it will be also manifest that the eighth *æquation* must be equall to the first, *viz.* } $\frac{RCA}{CR-SA} = B$

10 The ninth reduced will be —— } $RCA = BCR - BSA$

11 The tenth by *transposition* of $-BSA$ will be —— } $RCA + BSA = BCR$

12 If both the parts of the 11th. bee *applyed* to $RC + BS$ it will be —— } $A = \frac{BCR}{RC + BS}$

13 The twelfth *reduced* into *proportionalls* will be— } $RC + BS . BC : : R . A$

The 13th. *in words is the following Theoreme; viz. As the Aggregate of the Rectangle (or Product) of the perpendicular of the Triangle and the lesser terme of the proportion assigned, and the Rectangle under the Base and greater terme of the said proportion, is to the rectangle of the Base and Perpendicular; So is the lesser terme of the said proportion to the breadth of the long Square.*

By which *Theoreme* the breadth of the *long square* propounded will be found 42, and consequently, by the *Rule* of 3 and the *proportion* assigned

assigned, the length will be found 84, or the length might bee found *Analytically*; from whence another *Theoreme* would arise.

I shall conclude with an *Ænigma* wherein divers difficult *questions* are involved, the resolution whereof will discover a certain *Sentence* consisting of three words, concerning which you are to observe, that by each *letter* is understood the *number* which shewes the *seat* or *distance* of such letter from the beginning of the *Alphabet*, so by *C* the third *letter* in the *Alphabet* is understood 3, by *F* 6. by *P*, 15, &c. which numbers may be called the *Indices* of their respective *letters*, so that the *Index* of any *letter* being known, the *letter* is cōsequently discovered

The *Ænigma* followeth.

The *Product* or *Rectangle* of the *difference*, and the *difference* of the *Squares* of the *Indices* belonging to the second *letter* of the second *word* and the third *letter* of the first *word* is 576, and the *Rectangle* or *Product* of their *summe*, and the *summe* of their *Squares* is 2336, the *Index* of the said third *letter* being the greater.

The *Index* of the latter of the two before mentioned *letters* is the last of four numbers in *Arithmeticall proportion*, and the *Index* of the former is the first of the said foure *proportionalls*, the *lesser Meane* is the *Index* of the first *letter*

letter of the 3d *word* and the greater *Meane* is the fourth or last *letter* of the first *word*.

The 2d. *letter* of the 3d. *word* is the same with the 3d. *letter* of the *first word*.

The fifth *letter* of the 3d. *word* is the same with the *last letter* of the *first*.

The *summe* of the *squares* of the *Indices* of the first and second *letters* of the first *word* is 520, and the Product of the said *Indices* is equall to $\frac{2}{9}$ of the *square* of the *greater Index* which is the *Index* of the said *first letter*.

The *difference* between the last mentioned *Indices* is the *Index* of the first letter of the 2d. word.

The third or *last letter* of the second *word*; also the third *letter* of the 3d. *word* are the same with the 2d. *letter* of the first word.

The *summe* of the *Indices* answerable to the 4th letter of the third *word* and the 6th or *last letter* of the same word being added to the Product or Rectangle under them is 33, and the difference of their squares is 255, the *Index* of the said *last letter* being the lesser.

The *investigation* of the *Indices* by which the *letters* are consequently discovered, I leave to the scrutiny of the ingenious *Analyst*.

Soli Deo gloria.

Arts and Sciences Mathematicall,

Taught
At the corner houſe (oppoſite to the *white Lion*) in *Charles-ſtreet*, neare the *Piazza* in *Covent-garden*, or at the lodgings of ſuch as are deſirous, *viz.*

ARITHMETIQUE,

1. *In whole Numbers,*

2. *In Fractions*
   - *Vulgar,*
   - *Decimall,*
   - *Aſtronomicall.*

3. *The extraction of roots, viz. of the*
   - *Square,*
   - *Cube,*
   - *Biquadrate.*
   - *Quadrato-Cube,* &c.

   by *Rules* naturally ariſing frõ the *Geneſis* of *Powers.*

4. *Merchants Accompts,* in the *Italique* methode of *Debitor* and *Creditor,* according to the modern practice.

ALGE-

ALGEBRA, *viz.*

1. In *Numbers* and *Characters* according to the *Ancients.*
2. In *Species* or *Letters* of the *Alphabet,* according to the modern *Analyſts.*

with the uſe thereof in the invention of *Theoremes* and reſolution of ſubtile *Queſtions* and *Problems* in *Arith.* and *Geometry.*

GEOMETRIE, *viz.*

The works of *Eucl. Archimedes, Apollonius Pergæus, Pappus,* and other *Geometricians* , as well *ancient* as *modern* , explained & applied unto

1. Divers wayes of *Conſtruction, Menſuration, Reduction,* and *Diviſion* of ſuperficiall *Figures, viz.* of *Land, Board, Wainſcot, Glaſſe,* &c. Alſo of *Solids,* as *Timber, Stone,* &c. with the *Gaging of Cask.*
2. The *Projection* of *Planiſphæres, Maps, Charts,* (*univerſall* or *particular*) *Plots* of *Land, Architecture,* &c. with the *augmenting* or *diminiſhing* of them, according to any proportion aſſigned.

THE

The DOCTRINE of TRIANGLES, *viz.*

1. *Plain* — With their use, in finding of *Altitudes* and *Distances*, in measuring of *Land*, *Fortification*, *Dyalling*, *Navigation*, *Theories* of the *Planets*, &c.

2. *Sphæricall* — With their use, in the resolution of the usuall *Propositions* of the *Celestiall* and *Terrestriall Globes*, *Dyalling*, *Navigation*, &c.

NAVIGATION, *viz.*

In either of the 3 *principal kinds of sayling*, viz. — By the *plain Chart*. By *Mercators Chart*. By *great Circle*.

DYALLING, *viz.*

1. *Geometrically*, 2. *Instrumentally* 3. *Arithmetically* — With the *inscription* of the *Almicanthars*, *Azimuths parallels* of *Declination*, &c. Also the making of *reflexive Dyals*, shewing the houre without any shadow.

The

The Construction and Use of MATHEMATICALL INSTRUMENTS, *viz.*

1. The *Canon* of — *Sines*, *Tangents*, *Secants*, and *Logarithmes*.

2. The *Quadrant*, *Sector*, *Crosse-staffe*, *plain Table*, *Rule of Proportion*, *Instrumentall Dyals*, &c.

CHIROGRAPHIE, *viz.*

The Art of accurate and exact *Hand-writing*, in the *English* and best *Italique* formes, by genuine *Principles*, and plain *Demonstration*.

BY

JOHN KERSEY

Philomathet.

Vox audita perit, litera scripta manet.